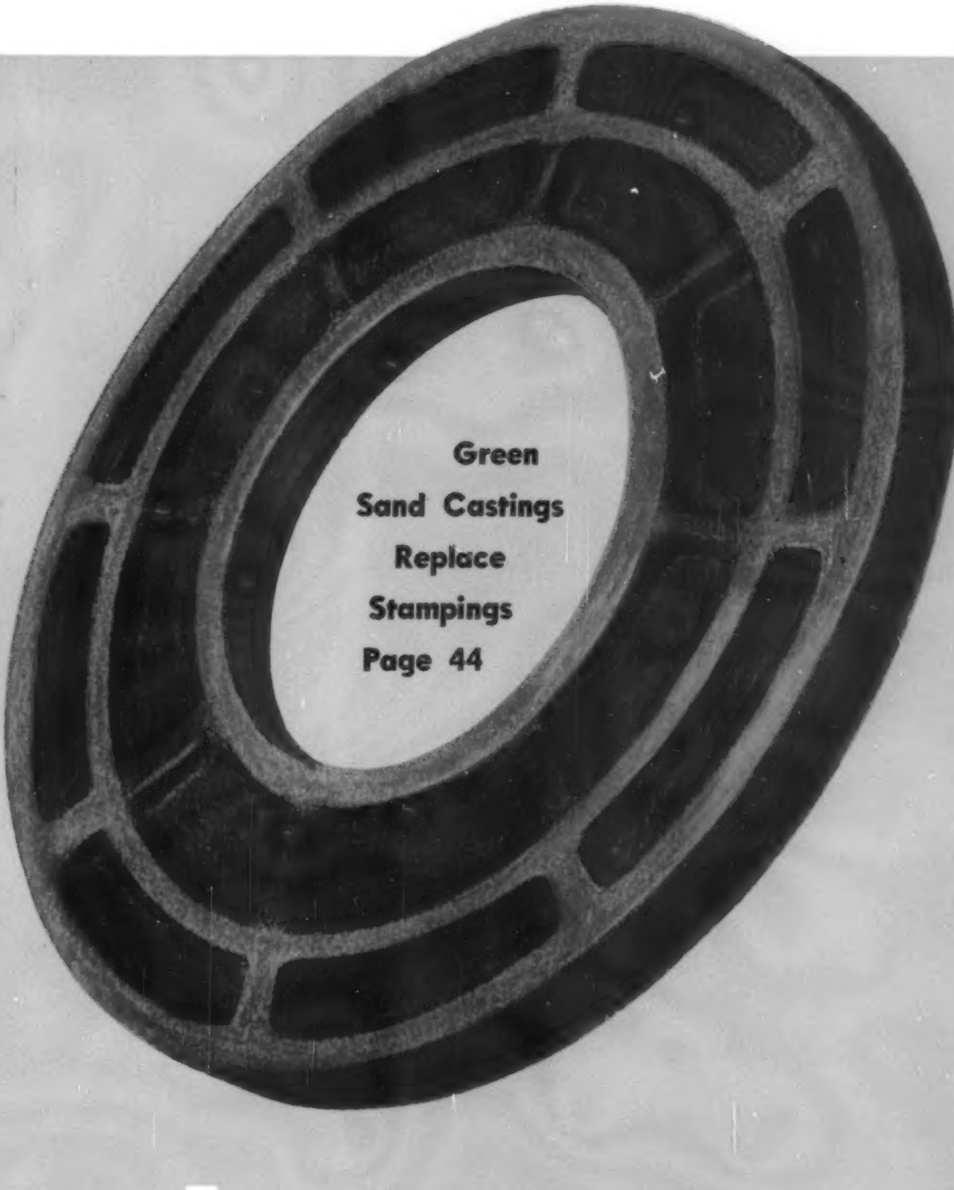
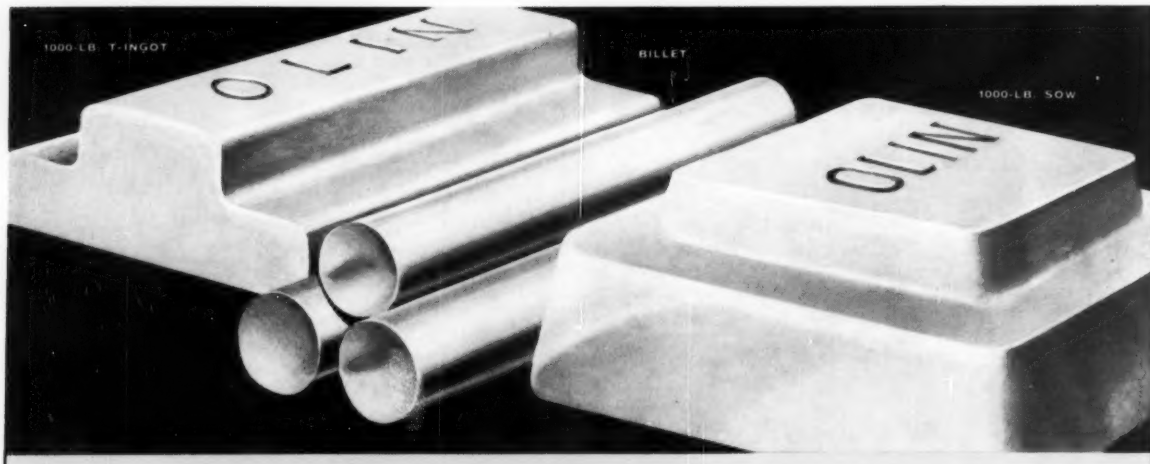


Green Sand Castings Replace Stampings Page 44

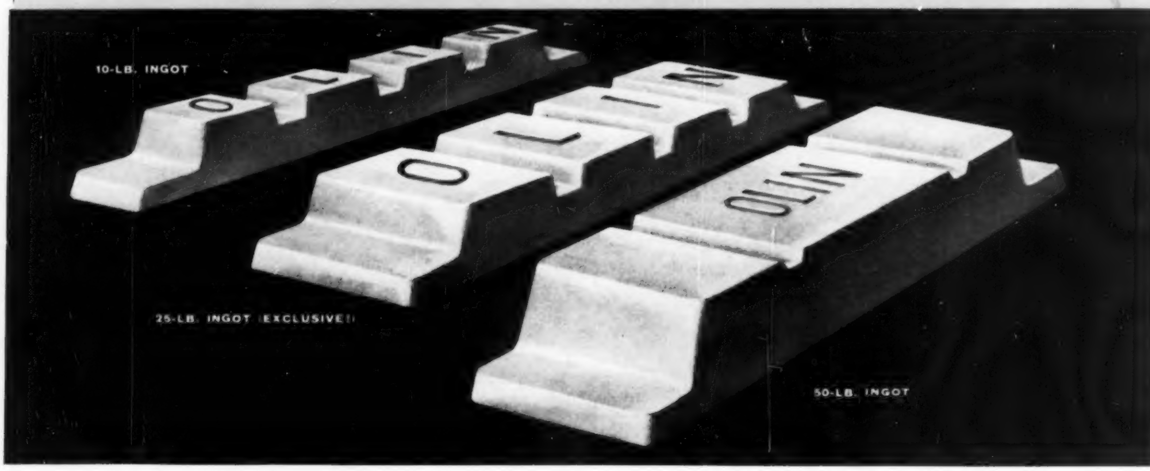
modern castings

FEBRUARY 1961



There's one for your every need

OLIN ALUMINUM PIG, INGOT AND BILLET



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Circle No. 121, Pages 145-146

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Circle No. 122, Pages 145-146

February 1961 Vol. 39, No. 2

modern castings

metalcasting "technology-for-profit"

COVER Drawn by CHARLES ROTH. See page 44 for details on how green sand castings replaced stampings.

MODERN CASTINGS is indexed by Engineering Index, Inc., 29 West 39th St., New York 18, N. Y. and microfilmed by University Microfilms, 313 N. First St., Ann Arbor, Mich.
The American Foundrymen's Society is not responsible for statements or opinions advanced by authors of papers or articles printed in its publications.
Published monthly by the American Foundrymen's Society, Inc. Publication office: 1309 North Main Street, Pontiac, Illinois, U.S.A. Editorial and executive offices: Golf & Wolf Roads, Des Plaines, Illinois. Subscription price in the U. S., \$5.00 per year; elsewhere, \$7.50. Single copies 50¢. May and June issues \$1.00. Second class postage paid at Pontiac, Illinois. Additional entry at Des Plaines, Illinois.

Circle No. 123, Pages 145-146

modern castings

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VAnderbilt 4-0181

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GENERAL MANAGER
WM. W. MALONEY

Let's look at . . .

Healthy Competition! – Not Duplication

H. E. Green

HOW MANY OF YOU know that our advertisers make possible *most* of the editorial material you receive in the magazine each month? Their advertising dollars pay a large portion of the bill. All of us know the result: *the improvement of the metalcasting industry.*

This advertising is not altruism, as these advertisers are alert, realistic businessmen—not contributors to a cause. They consider you an important market for their goods and services.

They buy advertising space on a *business* basis. They expect to make a profit from it. They know that MODERN CASTINGS has the largest circulation of any business magazine in metalcasting—and that it provides a *valuable* editorial "climate" for their advertising messages.

Also, they know they must compete aggressively for your dollars, your attention, and your loyalty. They have no monopoly on what you do—and they concentrate on presenting the merits of their products.

They advertise in MODERN CASTINGS because of our editorial excellence and technology-for-profit editorial policy. This includes:

1. Exclusive and important editorial material which cannot be found anywhere else—material needed by the readers to do their jobs and make their livings.
2. Editorial material (articles and news) which can best be presented expertly and authoritatively in MODERN CASTINGS.
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   - . . . the Market Opportunities series.
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Like our advertisers, who sell many types of products and services competitively, we know that a healthy industry must have many magazines, each serving specific needs.

We are not trying to be like other magazines or to copy what they do. Editorial pages are too precious. Also, we are against belittling our competition. We respect their efforts. And we concentrate on serving our readers with technology-for-profit information and help.

This is why MODERN CASTINGS has so much acceptance—and is the "hot" magazine in today's parlance.

Harold E Green

Looking at Business with Modern Castings

NATIONAL SCENE

Added confirmation that business will be better this year than last was made at the recent National Industrial Conference Board's economic forum. The panel of economists concur that strengthening demands for finished products, plus high confidence of businessmen and consumers will stop any recession. Another favorable factor is relative price stability. No change in the wholesale price index in 1961 is anticipated, and the consumer price index will rise only one point, they believe. The gross national product will climb to an annual rate of $518 billion by end of 1962. It now stands at $502 billion.

EXPANSION

American Brake Shoe Company has just formed, with a Mexican firm, a million-dollar foundry subsidiary in Mexico. Brake Shoe President Kempton Dunn reports the new subsidiary, Amsco Mexicana, S. A., will solve the "increasingly difficult problem of supplying the growing Mexican market with high quality carbon steel and manganese steel castings in the face of tightening restrictions on imports into that country." Near Mexico City, the foundry has a capacity of more than 400 tons of steel castings per month. Output will go to Mexican construction, mining, cement, and other heavy industrial industries. A large part of production will be replacement parts for U. S.-produced equipment used in Mexico.

Expenditures for new plant and equipment by U. S. primary iron and steel manufacturers, exclusive of metal fabricators, continued high in 1960, well above the 1959 level, according to the Securities and Exchange Commission. Also the commission estimates expenditures will remain high during the first quarter this year.

Iron and steel producers spent $1.6 billion for plant and equipment during the first quarter last year, $1.75 billion in the third quarter, and $1.5 billion in the last quarter.

Sales at Allis-Chalmers Manufacturing Co. this year are expected to be as good as 1960. And the profit picture should be better than last year's, according to President R. S. Stevenson. Predictions are based on gross farm income remaining equal to 1960, with dealer inventories and farm equipment purchasing returning to usual levels; increased highway construction stimulating construction machinery buying; and firmer prices for capital goods, total orders for which will come very close to 1960 levels.

Also, Wm. J. Grede, president of J. I. Case Co., predicts a steadily increasing demand for farm equipment and other durable

goods in 1961. He reports dealer inventories have been cleared, which makes his firm's outlook encouraging.

Estimated earnings for The Central Foundry Co., New York City, in 1960 totalled $1,350,879 compared to $1,275,575 in '59. This increase was made despite a three per cent decline in company shipments, reports President Sidney Gondelman.

Aluminum Company of America has begun operations at their new aluminum die casting plant, near Metuchen, N. J. Several die casting machines are in production at present, and the facility will produce permanent mold castings when additional facilities are installed this spring. The completed unit will supplant the firm's Garwood (N. J.) die casting works and its permanent mold foundry at Bridgeport, Conn.

FERROUS SHIPMENTS

Gray iron castings shipped last October totalled 905,139 short tons. This is 4,642 short tons more than September shipments, and 33,590 short tons above October '59 shipments.

A total of 63,521 short tons of malleable iron castings were shipped in October, compared with 63,048 short tons the month previous.

Demand for steel castings was down 1,634 short tons in October from the previous month. October shipments were 102,664.

NON-FERROUS SHIPMENTS

Shipments of non-ferrous castings in October totalled 183,-536, a jump of 3,592 thousand pounds over the previous month. Of this, there were 59,853 thousand pounds of copper and copper-base castings shipped; 63,684 thousand pounds of aluminum and aluminum-base castings; 56,201 thousand pounds of zinc and zinc-base alloy castings. Also total of 2,038 thousand pounds of magnesium and magnesium-base alloy castings were shipped during October.

DEPRECIATION

Tax relief may come through faster write-offs if the strategy of business groups is successful in Congress this session. Consequently, there'll be increased spending for new plants and equipment. Quicker depreciation would also aid in cutting production costs, and thus prices on goods sold here and overseas would decrease. Result: increased U. S. export income.

STEEL

Production is expected to increase 5 to 10 per cent above December, and by March and April orders are expected to improve substantially. Vigorous activity will follow by mid-year. Year-end steel scrap prices were up, activated by export demands and speculative buying by brokers. Top, $5.60 per ton.

MAGNESIUM

Volume usage of magnesium die castings in automotive engines, transmissions, and structural interior components is imminent, according to Robert Pittsley, sales manager of a Dow Chemical Co. office. According to Pittsley, the firm is offering to die casters various kinds of assistance to prepare for this up-turn. He predicts that by 1965 the automotive industry will use more than 10 pounds of magnesium per car.

Millions have been made and saved

with UCM's "FIVE-DEEP" Ferroalloys

Metal producers in their ceaseless drive to improve products and profits are learning the value of Union Carbide Metals' FIVE-DEEP ferroalloys. Here are some of the advantages these alloys provide.

Five Extra Values in Depth

1 Technology—many million dollars a year, invested in UCM's 600-man research and development center—helps you produce more profitable metals. The payoff has been progress—over 100 new alloys and metals—providing countless ways to improve your products.

2 Customer Service brings you our integrated experience in the application of ferroalloys to various melting practices. Engineers from 9 UCM field offices travel a million miles a year to provide on-the-scene technical assistance.

3 Global Ore Sources assure you uninterrupted supplies of ferroalloys. UCM's close association with many mines throughout the world provides dependable raw material sources.

4 Unmatched Facilities free you from delivery worries. Only UCM gives you 6 plants—3 with their own power facilities—and 17 warehouses, all located for fast shipments by rail, truck, or water.

5 Strictest Quality Control—with over 100,000 tests per month from mines to shipment—makes sure you always get alloys of uniform size and analysis, with minimum fines, lot after lot.

For better metals, production economies, bigger profits, insist on UCM's FIVE-DEEP alloys. Union Carbide Metals Company, Division of Union Carbide Corporation, 270 Park Ave., New York 17, N. Y., producer of "Electromet" brand metallurgical products.

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UNION CARBIDE METALS

Only **ELECTROMET** ferroalloys from **UCM** are so deep in extra values to help you.

Circle No. 138, Pages 145-146

Around the World with Modern Castings

UNITED STATES

Research Development Corp. of America announced a breakthrough in a steel heat treating technique which promises huge gains in metal strength. The treatment, termed "Thermomagnadynamics" has been credited with increasing ultimate tensile strength up to 60 per cent plus simultaneous improvement in ductility, fatigue strength, and impact resistance. Materials heat treated to a hardness of Rc 62 can be bent at least 100 degrees without fracture. The process rearranges the metal grains into an homogenous ultra-fine isotropic granular structure. AISI type 4340 steel has been treated to achieve 335,000 psi ultimate tensile strength, 11 per cent elongation, and 28 per cent reduction in area!

WALES

The traditional use of gray iron for permanent mold dies is being challenged by ductile iron. Dialoy, Ltd. is using fully annealed spheroidal-graphite iron (ductile iron) for making die blocks. They have found this the most suitable material for withstanding high thermal and mechanical shock at elevated temperatures. A two-ton die assembly was recently used to cast aluminum tanks for 5, 10, and 15 kva electrical transformers—also a new end-use application for aluminum castings.

ITALY

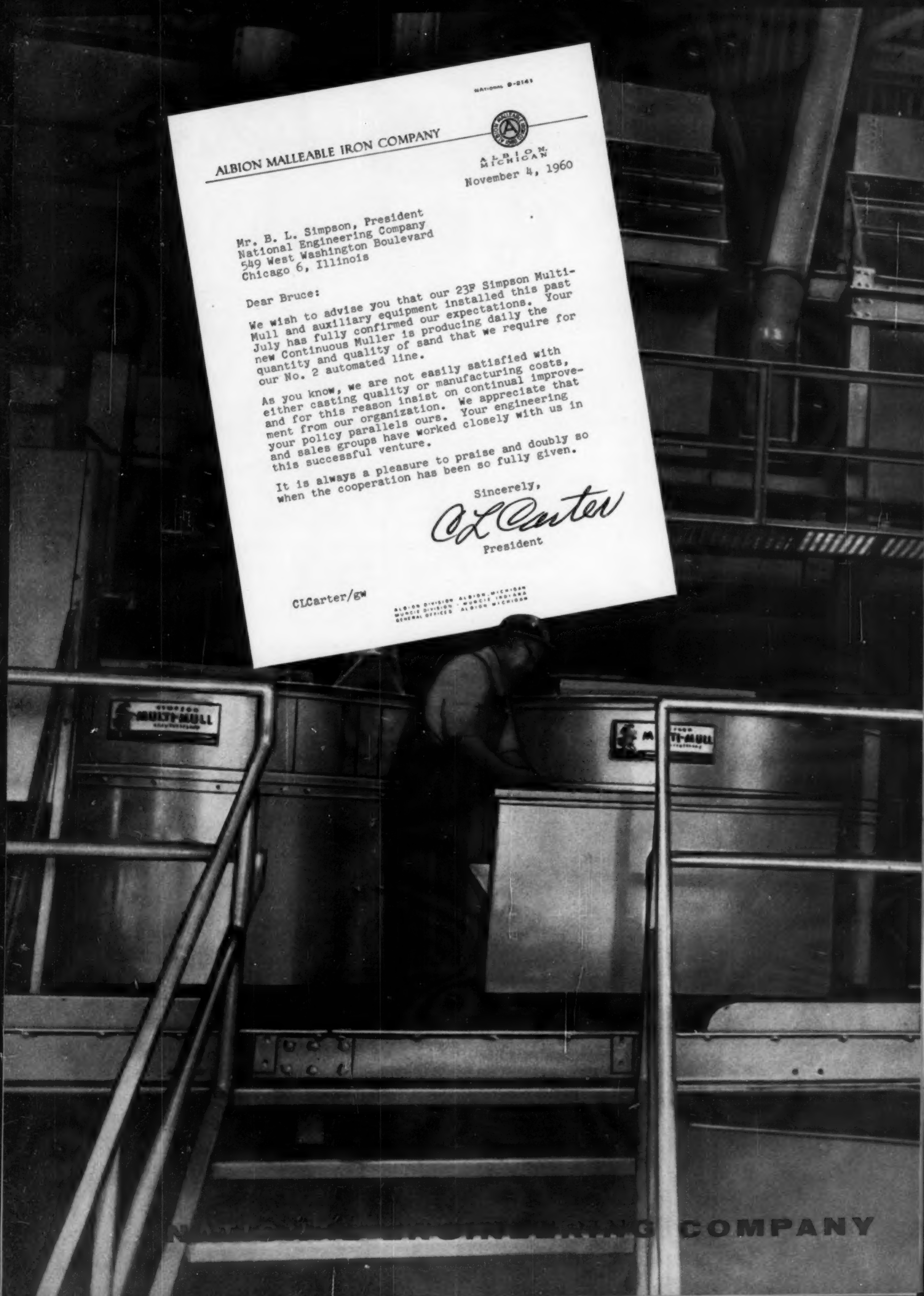
Many attractive incentives are being offered to encourage U. S. companies to invest in Italy. Included are tax exemptions for 10 years, import duty exemptions and special low-interest loans. Some of the U. S. companies taking advantage of Italy for overseas operations include Beloit Iron Works, Allis-Chalmers Mfg. Co., Armco Steel Corp., American Machine & Foundry, Link-Belt Co., and Crucible Steel Co. If you want more information detailing the advantages of locating in Italy, just write MODERN CASTINGS requesting a copy of a 32 page report "Investment in Italy."

JAPAN

Fluid flow of molten metals within molds can now be actually observed and photographed. Shoboyaski and Okomoto have developed an engineering set-up involving: 1. a shell mold; 2. a 200 kv x-ray source, which produces a shadow of the flowing metal on a fluorescent screen; 3. an intensifying screen which clarifies and brightens the image; and 4. a special camera to photograph the image.

A study of the high speed movies taken while metal flows into the mold reveals exactly how a gating system functions regarding fluid flow and turbulence. Step-gating systems were observed to feed metal in spurts and not sucessively from bottom to top. This new combination of tools led to design of "saxophone" gating system

(Continued on page 14)



ALBION MALLEABLE IRON COMPANY

ALBION, MICHIGAN

November 4, 1960

Mr. B. L. Simpson, President
National Engineering Company
549 West Washington Boulevard
Chicago 6, Illinois

Dear Bruce:

We wish to advise you that our 23F Simpson Multi-Mull and auxiliary equipment installed this past July has fully confirmed our expectations. Your new Continuous Muller is producing daily the quantity and quality of sand that we require for our No. 2 automated line.

As you know, we are not easily satisfied with either casting quality or manufacturing costs, and for this reason insist on continual improvement from our organization. We appreciate that your policy parallels ours. Your engineering and sales groups have worked closely with us in this successful venture.

It is always a pleasure to praise and doubly so when the cooperation has been so fully given.

Sincerely,

C L Carter

President

CLCarter/gw

ALBION DIVISION ALBION, MICHIGAN
MUNCIE DIVISION MUNCIE, INDIANA
GENERAL OFFICES ALBION, MICHIGAN

(*Continued from page 11*)

for minimum turbulence. Besides gating design, important conclusions are forthcoming regarding generation and elimination of gas bubbles during casting. This unique approach opens new worlds of observation which lead to revised thinking about gating.

ENGLAND

New economy has been introduced at Bristol Siddeley Engines, Ltd. into the investment casting process by development of a cement bonded back-up material for pre-coated wax patterns. About 12 per cent cement (aluminous or Portland) is mixed with firebrick grog, chamotte, and water. Elimination of expensive binders has produced a secondary investment material with high green strength to prevent mold cracking during de-waxing, low hot strength to prevent hot tearing, and high refractoriness which prevents mold cavity distortion. Castings shake out easier and have high dimensional accuracy.

EUROPE

"Because American firms often don't understand the many pitfalls of foreign purchasing and its changing nature, some companies lose money when they buy overseas", says John R. Blinch, Executive Secretary of the European Federation of Purchasing Officers. Blinch is conducting seminars in the United States to help business men avoid costly mistakes in purchasing industrial products in Europe and Asia.

The importance of a better understanding of foreign trade "rules of the game" is underscored by a recent statement by Paisley Boney, President of the National Association of Purchasing Agents. "With world commerce becoming more significant in American and foreign competition, knowledge of buying and trade practices abroad is important to the professional purchasing man. This is true whether his organization now buys overseas or not".

Foundrymen are going to find more and more opportunity to become involved in buying and selling activities with foreign companies. And there's a lot to be learned when it comes to bargaining in francs and marks.

RUSSIA

Conventional opinions consider die casting of carbon and stainless steel components to be impossible but Russia continues to experiment with the process. Steel at 2875-2950 F. is being injected into dies preheated to 212-300 F. Casting pressure ranges up to 1000 atmospheres. Castings, weighing as much as 10 ounces, had good mechanical properties. Evacuated dies minimize porosity problems. Alloy tool steel dies last about 20 casts. Armco iron, mild steel, copper and copper alloys display much longer die life but strengths are insufficient. Finding a suitable die material remains the principal road-block in this process. Read "Cloud Nine"—"Permanent Mold Casting of Steel, p 40 in this issue of MODERN CASTINGS for detailed report of progress in permanent mold casting of steel.

GERMANY

The use of glycols as a complete or partial replacement for water in bentonite bonded sands is receiving attention in German foundries. Casting defects attributable to moisture in the mold can thereby be reduced. MODERN CASTINGS will bring you more information on this new development soon!

Reader Opinions and Ideas . . .

INVESTMENT OPPORTUNITY

In your department "Around the World with Modern Castings" in the December issue, I noticed that some United States firms are interested in investing capital and know-how in foreign countries where production facilities are available.

I would appreciate hearing from any of these firms. I am associated with a group who has been in the cast iron foundry business for 30 years and is willing to move to a better location with modern equipment. We are willing to invest up to 50 per cent in this project. The government of Israel is giving its support. This together with the expanding economy of the country makes the investment an attractive one.

Enclosed is my Reader Service card and an order for books. I would also appreciate any literature and pamphlets which will widen my horizon and assist me in rendering better services to clients from the American markets.

Y. G. Wahba
Technical & Advisory Services
Haifa, Israel

REQUESTS ASSISTANCE

I am an AFS member and will finish my engineering course here in Germany during May. After that I would like to study for an M.S. or PhD. degree and would like to get a position in the research laboratory of an American plant or institute.

If this is not possible I would like to obtain employment in an iron or steel foundry, particularly one which has operations in India or which has contacts with Indian iron or steel factories.

N. P. Dhawan
Von Pastor St.
Aachen,
West Germany

INDIANS SEND THANKS

Please accept our thanks for the fine cooperation and generous hospitality extended to members of the India Foundry Study Team during their recent visit to your Society.

The participants were quite impressed with the program provided. Their evaluation meeting proved that they received considerable information

which will be valuable to them in India.

Thanks again for your help in our technical assistance program.

Wm. R. Boynton, Project Manager
Processes & Techniques Studies Branch
Office of Industrial Resources
International Cooperation Administration
Washington, D. C.

BACKS 2-YEAR COURSE

Thank you for the notification that a story on the Western Michigan University foundry program will be in the February issue of Modern Castings (See page 134).

In my opinion, the development of collegiate level technical programs for our industry is extremely important as we have a growing need not only for technicians but for foremen with something more than a high school education and something less than a full four-year degree program.

Graduates of two-year technical terminal programs will undoubtedly, in the course of their careers, require further education in addition to their work experience. Therefore, in developing programs of this type, I think we are automatically sowing seeds for future T&RI registrations. I guess you would call this cross-fertilization.

T. T. Lloyd, Vice-President
Albion Malleable Iron Co.
Albion, Mich.

SAFETY EQUIPMENT

We would like to receive your comments and ideas as to the use and values of leggings or spats. We have been using a knee-length leather legging with an extra long neoprene shield that extends over the top of the shoe. These leggings have been required by all men on the pouring line and all ladle men.

We receive two major complaints. First is that the men get more frequent small burns on the legs from splashes of metal that get trapped between the leggings and the leg.

The second is that the leggings catch on the jackets and cause men to trip. Our first aid and accident records show that there has been an increase in small burns around the calf of the leg.

The reason metal gets trapped behind the leggings is that they are not being worn properly. The pants should be cuffed over the top of the

legging, thus making it impossible for metal to get trapped. The alternate to this is to supply hip-length leggings which really are protective pants.

The reason the leggings catch on jackets is because they are not lashed properly to the leg and the shield or spat is not secured to the shoe. Leggings should fit fairly tightly but not so tightly as to interfere with circulation.

Where the leggings are properly worn and lashed, there will be no trapping of metal or catching on jackets any more than the ordinary workpants will catch on jackets.

If you are using spring leggings, perhaps you should change to the springless type which are fitted with straps for close fit.

Many foundries and most steel mills furnish hip-length leggings because they are more comfortable and there is no need to constantly check whether or not workmen are cuffing the pants over the legging and adjusting the straps properly. HERBERT J. WEBER, Director, AFS Safety, Hygiene, and Air Pollution Control Program

HOT CORE BOX PROCESS

In the December issue of MODERN CASTINGS, James F. Tetzlaff of GMC Detroit Diesel Engine Div. requested information on the hot core box method for cores used by the Renault Works in France.

One of the papers to be presented at the 65th Castings Congress by the Sand Division describes this method. It is written by Phillipe Jasson, Regie Nationale des Usines Renault.

This paper will appear in the TRANSACTIONS section of MODERN CASTINGS.

T. W. SEATON, Vice-President
American Silica Sand Co.
Ottawa, Ill.

THANKS FOR COPIES

Many thanks for sending us 25 copies of MODERN CASTINGS for use in the commercial libraries.

The libraries are so much in demand overseas that we are planning to send out as many as 50 a year. For this purpose, we would like to receive a new supply of your publication about every six months.

E. PAUL HAWK, Director
Trade Missions Program
Office of Trade Promotion
U.S. Dept. of Commerce
Washington 25, D. C.

SAFETY ARTICLE SCORES

Will you please forward the literature describing further details on items discussed in the December issue of MODERN CASTINGS entitled "Now You Can Be Fashionable! Look Smart! Be Safe!"

We would particularly like literature on ear protectors, on the various types of glasses, goggles and face shields, and on all the aluminized fabric clothing discussed in the article.

May we take this opportunity to comment on the continued excellence if the editorials and articles. We are quite sure that we can express the feelings of the vast majority of the AFS membership when we say that we are very proud of our magazine and there is now no doubt that MODERN CASTINGS is the leading technical publication by and for the foundry industry.

J. G. WINGET
Foundry Superintendent
Manager, Furnace Div.
Reda Pump Co.
Bartlesville, Okla.

Editor's Note: Literature covering the safety equipment items has been forwarded. Others interested in this equipment may write MODERN CASTINGS *for information.*

WANTS INDEX COPIES

Having saved MODERN CASTINGS we are interested in purchasing indexes if available.

Will you please send copies for 1957, 1958, 1959, and 1960.

HARLEY E. DENNEE, Secretary
Acme Pattern Co.
Flint, Mich.

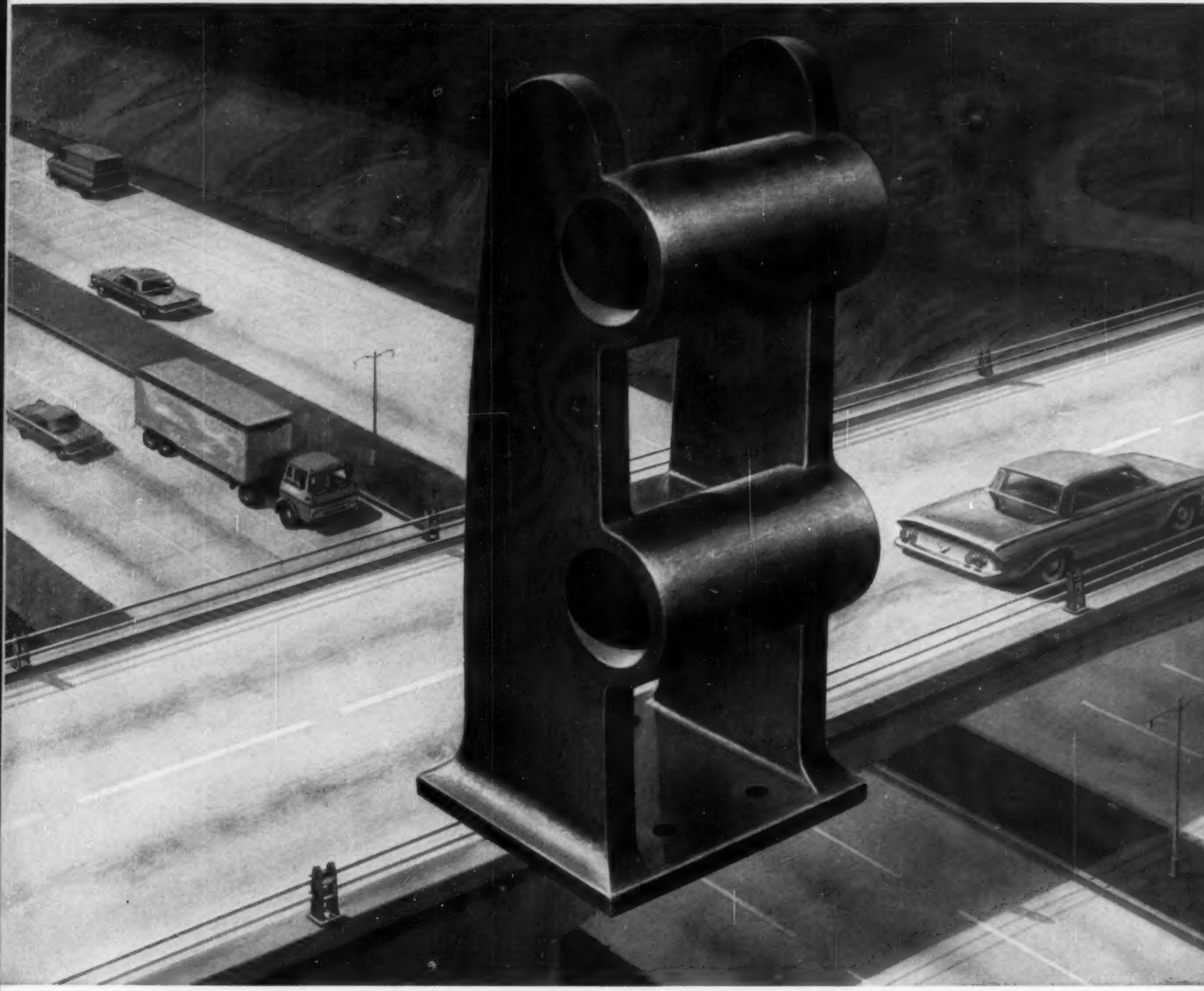
Editor's Note: A limited supply of indexes are available as long as they last. Anyone desiring copies should write to MODERN CASTINGS *indicating the years desired. These annual indexes are currently available for the past 10 years.*

THANK YOU FROM JAPAN

I wish to express my sincere thanks for your kindness shown to me while visiting in your country. The wonderful hospitality and courteous support made my trip most enjoyable and memorable.

FUKUJI OKUMURA, President
Nippon Steel Foundry Co.
Chishima-Cho Taisho-ku
Osaka City, Japan

Circle No. 142, Pages 145-146



Take Chance Out of Safety

by Herbert J. Weber

Many of you have heard of the game called Russian Roulette. In this game, life and death are the stakes. The rules are simple: Two players are each supplied with a gun containing one bullet in the revolver. The revolver is spun; the gun pointed at the player's own head and the trigger pulled. If the gun fails to fire, the opponent takes his turn. The game is thus continued alternately until one player is killed.

The odds, of course, are five to one on each spin of the revolver that the bullet will not be in the firing receiver. None of us would think of playing this risky game, even with such good odds, because the stakes are too high.

Know the Odds

Also there are, no doubt, many of you who wouldn't gamble on a roulette wheel because you know the odds are with the house.

There are others, however, who will play the game, knowing full well there's little chance of beating the wheel no matter how long it is played. But at least in this activity there is some fun; an element of fascination, plus the anticipation (and hope) that every now and then you may win.

There is another game called "Industrial Roulette," which apparently many of us don't even hesitate to play. Yet the stakes are pretty high and the odds not so good as in Russian Roulette, or the roulette wheel.

The industrial version is "chance taking;" and the stakes are loss of a limb or body organ and sometimes death. In this game, the player commits an unsafe act on the gamble that he will not be injured or killed. As in Russian Roulette, he continues to commit unsafe acts until the law of chance catches up with him.

Also in playing industrial roulette, unlike playing the roulette wheel, there is no fascination. The players never win anything; chances are they're the losers of *everything*. And brother, I can tell you that workmen's compensation will never repay you for a lost hand, eye or other body part.

When this happens the player is handicapped. All of us know what a handicap is. In horseracing it is the greater weight a horse carries compared to that of another horse. In bowling or golf it is a system of scoring, so that poorer bowlers and golfers can compete with better ones.

A body handicap on the other hand, is the loss or lack of use of some part of the body; and a person so afflicted must compete at a great disadvantage with others.

A handicap renders the whole job of living and working harder. It is true that handicapped people have done some remarkable things, but there are few Helen Kellers.

If you want to appreciate how tough a handicapped person's lot is, try doing your daily tasks with one knee in a splint or try getting dressed tomorrow morning with one hand. If that doesn't impress you, blindfold yourself and try lighting a cigarette or pouring a cup of coffee.

Stakes are High

So if you want to be handicapped, take chances; after all the odds are that you might get away with it. But remember that the stakes are drastically high for what you may get by with . . . but if you don't?

If it's too much bother to lock out the main switch when repairing power machinery; to wear safety goggles and other personal protective equipment; to check for a hot wire with a test light rather than your bare finger; and to take the time and effort to do an act safely, brother you're playing industrial roulette!

I predict here and now that if you continue this fool's game, the law of chance will catch up with you. When it does, you'll carry a real handicap and your family will pay the stakes along with you.

So leave handicaps to horses, golf, and bowling, and industrial roulette to damn fools.

Communications . . . An Industrial Headache

By R. E. Betterley

Communication is unquestionably the most important tool possessed by man. Yet, in industry today it is also one of the least understood;—is poorly "sharpened" and often misused. The word "communicate" is derived from the Latin words "communicare" and "communis," meaning "to share in common."

You can talk and gesture until red in the face, yet complete communication does not exist unless you and the recipient have your thoughts in common and share your mental picture and understanding. This sharing and understanding is best created with "two-way" communications—when both sender and receiver can see the picture in the other person's mind, *as he sees it*.

To have communication, there must be the same essentials necessary for the transmission of sound;—sender, carrier (form or medium) and receiver. Without one, communication does not exist. If weakness exists in one, communications likewise are weak. For example, the sender may give a poor signal or an incomplete signal and communications break down. Also, the carrier may be lacking (such as inadequate selection of words, a poor drawing, or the receiver is a "poor listener") and communications again bog down.

Communicating could also be called "getting through"—"putting it across" —"making ourselves clear" or "passing the word." Call it whatever you will; we must, however, never lose sight of its basic meaning—"to share in common." And most important of all, neither should we forget its primary function—"to get action."

Successful companies obviously appreciate the importance of good communications. However, the value of *reminding* as well as *informing* should not be overlooked. *One is as important as the other.* It's somewhat like the foundry manager who said, "We know what good cupola operation is but we don't do anything about it."

The primary responsibility of management is leadership. And the benefits of sound leadership can only be accomplished through people. People, in turn, must be motivated and directed through, *and only through,* communications in one form or another.

The scope of communications is difficult to comprehend. Without communications understanding, group effort, company activities, direction and even personalities would not exist. Wars have been started, won and lost because of the strength and weakness of communications. Business spends billions of dollars annually on letters alone. Management should consider what each letter, memorandum, purchase order, etc., costs *when all items are included.* Furthermore, what do these means of communication cost when they are *weak* or in *error?* Such mistakes or failure to get information "across" is a real headache costing millions of dollars annually.

Breakdown in communications can "snowball" into chaos in a plant's operations. Supervision, maintenance, instruction, safety and production can fail to the point where equipment "down time", deliveries, quality control, human and customer relations, and costs can lead to company disaster. With poor communications, money is thrown away. Yet, because of its intangible nature, we are all inclined to overlook the *real* culprit—*poor communications.*

Employees become more creative and productive when they feel they are sharing in the planning, problems and successes of a company. Personnel morale is improved with good communications *between* management and supervision. It has been said that about 65 per cent of all grievances are brought to *foremen first,* rather than stewards. Over 77 per cent of grievances are settled at the foreman level with the remaining 23 per cent costing companies tremendous amounts due to shutdowns and work stoppages.

Next month—
"Means of Communicating."

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Circle No. 145, Pages 145-146

Engineering Alumni Tell Educational Needs

by H. F. Dietrich

Since my column "What Price Engineering Education" appeared in the June Issue of Modern Castings, I have had some interesting suggestions about how this lopsided education problem could be solved. One idea was that the schools should ask the men in industry what they missed most in their education.

Such a survey was made by Columbia University with confusing results. It revealed four phases in the life of an engineer, but did little to help plan the curriculum of future engineers.

1. From 1 to 5 years after graduation, the alumni felt that they had been cheated in practical courses.

2. From 5 to 15 years, they felt that they should have had more math., physics, chemistry, and basic science.

3. From 15 to 25 years out of school, they felt that public speaking, business organization, finance, and labor relations should have been given more time.

4. Above 25 years the graduate engineer felt that he should have had more education in music, literature, drama, and the fine arts.

If the schools were required to teach all that these graduate engineers felt they should, an engineer would graduate in June and draw his first social security check in July. There is an area of self-education that must be explored when a student leaves the university. It is in this area that he learns to live with the world.

Let's analyze this report starting with the last point. The engineer who has worked 25 years in industry has decided that there must be more to life than hustling for a buck. He has learned to live and he thinks he could have learned this a lot earlier if the school had prepared him for it. He doesn't realize that without the preliminary climb through the ranks he wouldn't be in a position to enjoy life at that level. If by this time he hasn't learned to enjoy "The Overture from Hanzel and Grettel," or "Plato's Republic," perhaps it is because his natural attitude is better suited to "The Missouri Waltz," and Cooper's "Leather Stocking Series." There is nothing the school could have done about that.

The answers from the 15 to 25-year men reflect a change in the source of top management in industry. There was a time when top management came from the sales ranks. The first axiom of salesmanship is, "Sell Yourself." The peddlers took advantage of their training to gain top positions in industry. By selling himself to the boss—or the boss's daughter—many a top management man was created. Industry can no longer afford the luxury of supporting a son-in-law unless he can produce demonstrable results.

The answers of the 5 to 15 year men confuse me. In order to get more basic science beaten into our engineering students, we would have to invent new fields. Perhaps this is a reflection of lack of attention during classes, or a lack of application after graduation. In his first 5 years after leaving university, the neophyte engineer will find very little use for calculus II.

Now, about that first group. Aren't they in the best position to know the areas in which they should have had more training? Isn't it for these people that the schools exist? When a student dons the cap and gown and goes through the ritual of swinging the tassle from side to the other, we call it commencement. We don't claim that he has finished his education, only that he has been prepared for the future. If his education is inadequate *at this point*, the schools have failed him. These are the men who claim they should have had more practical courses—the studies that the egg-heads are squeezing out of the curriculum.

Editor's Note: Agreements or disagreements are solicited.

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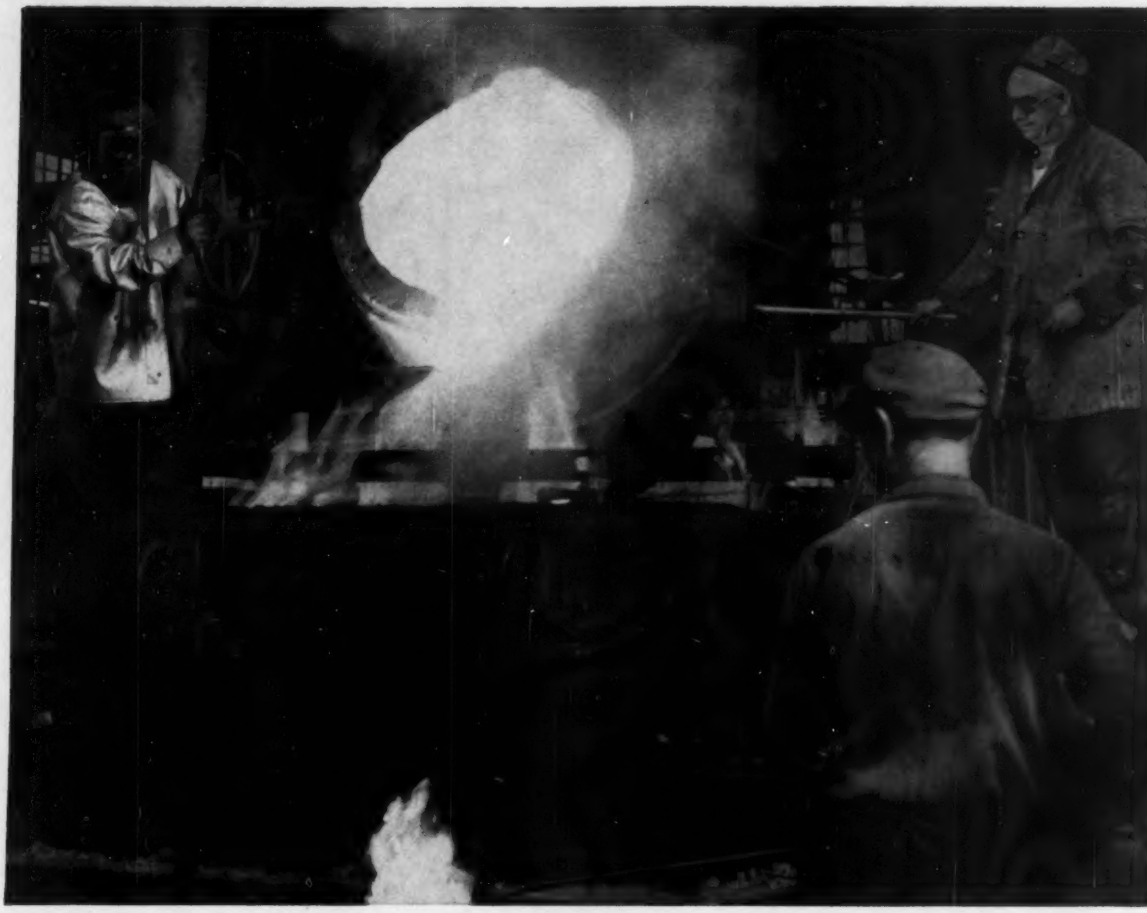

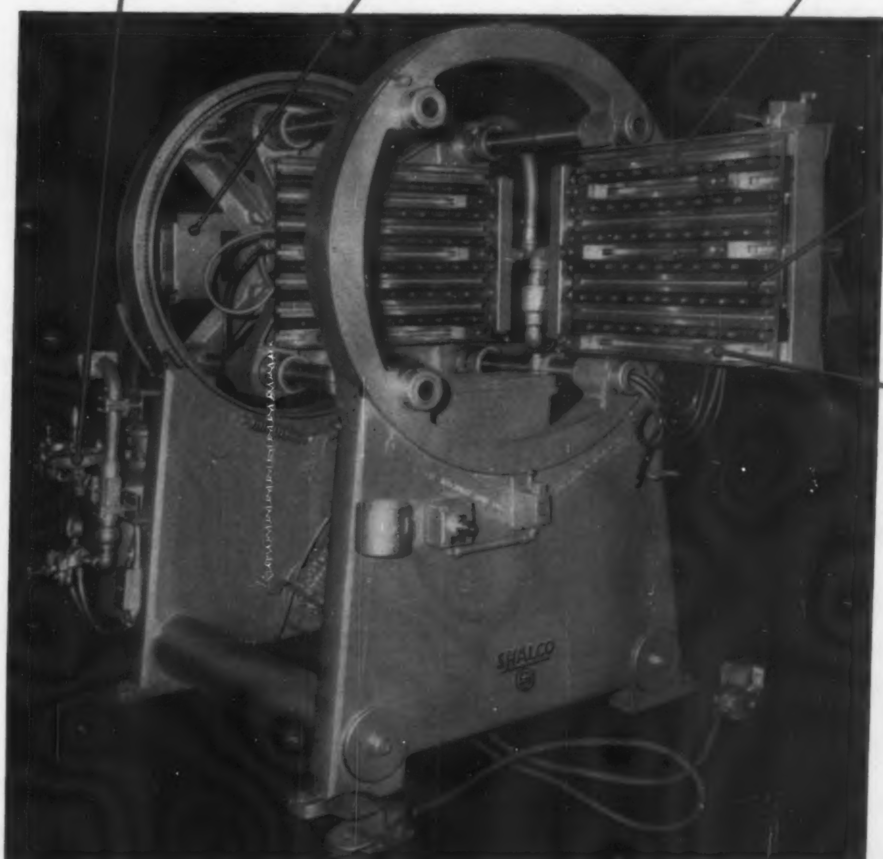

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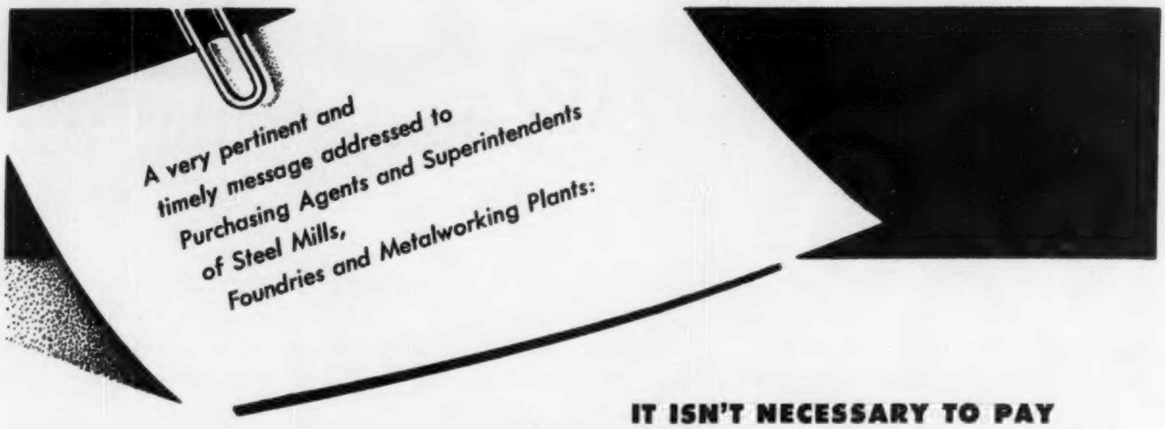

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Circle No. 148, Pages 145-146

New Sand Practices Produce Five-way Profits

Technology enables metalcasters to:

- *Make salable castings with less grinding*
- *Improve yield: casting weight to metal melted is 58 per cent*
- *Reduce draft on patterns*
- *Improve dimensional accuracy*
- *Eliminate mold and skin torch drying*

by W. D. McMillan, Contributing Editor

At least five profit-producing results have come from new sand practices developed by a team of foundry experts at Kensington Steel Co., Chicago. The metalcasters, spurred by a technical article published in Modern Castings about 18 months ago, have produced a facing sand mix which has improved castings quality and reduced costs.

Having read "Industrial Application of Olivine Aggregate" (Modern Castings, June 1958), the team put the technology to work and came up with significant contributions to their company and to the casting industry.

The sand mix uses olivine flour, silica sand and an air-setting binder. This mix produces the following savings:

1. Less draft needed on patterns lowers machining time. A roll shell is now cast with a draft of 1/32-inch instead of 1/4-inch per foot.
2. Eliminates mold drying and skin torch drying.
3. As-cast surfaces are smooth and free of scabs.
4. Better finish lead to a reduction of grinder operators in the cleaning room from 11 men to 2.
5. Improved dimensional accuracy effected reduction in machining time. For instance, machining time on a 1760-pound roll shell was cut from 18 hours to 8 hours. This casting has a two-inch wall thickness and a 40-inch top diameter which is held to a total tolerance of 3/16-inch.

These results depended on concerted team effort. Paul Schroeder, plant superintendent; Leo Marinelli, superintendent of the core room and sand control; Joe Seymour, foundry metallurgist; and Frank Skalka, molding foreman cooperated on the project. They were confronted with some physical limitations of available facilities and determined to expend a minimum capital.

Principal product at Kensington is Hadfield mangenese steel castings for impact and abrasive wear applications—jaw plates for crushers, bowl liners and mantles, screen bars for grizzly separators, roll shells, mill liners, and crawlers treads.

Due to the difficulty in machining austenitic steel, cast-to-size "foundry fits" are almost a must. This means close dimensional tolerances, satisfactory finish, and freedom from warpage. In fact, production of usable castings right out of the cleaning room is Kensington's goal.

The new practice, essentially a matter of mold preparation or sand treatment, involves the use of olivine sand with an air setting binder compound. Olivine is a natural mineral aggregate, about 90%

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Close up view of casting shows how today's modern practices with olivine sand facing creates superior finish. Grinding is minimal. This contribution to metalcasting was generated by an article in Modern Castings.

magnesium ortho silicate (forsterite). As olivine sand is a manufactured aggregate it is available in several grades—AFS No. 45, 70, and 130, and No. 200 flour.

Molds are faced with a mix containing 3 per cent air set material and 14 per cent olivine flour. The balance is a 4 screen washed and dried silica sand AFS grade 56.

The use of olivine flour is only one part of the new development as the use of an air setting binder compound is an essential and equally important part.

The air setting material is fast setting. Mold hardness develops rapidly in 45 minutes to 90 minutes. Hardness is so high that it exceeds the scale. Mold drying and torch drying no longer are necessary.

Timing in mold preparation is quite critical. The facing material is dumped onto the pattern using about 1 inch of facing for each inch of metal thickness to be poured against it. The back-up sand, usually placed with a slinger, must be added within 15 to 20 minutes after applying facing. This assures a bond between the facing and the back-up sand.

The metal poured is representative of the accepted analysis for Hadfield steel. Pouring rate is extremely important. At Kensington's foundry it ranges from 150 to 300 pounds per second. The rule on pouring temperature is rather simple; pour as cold as possible.

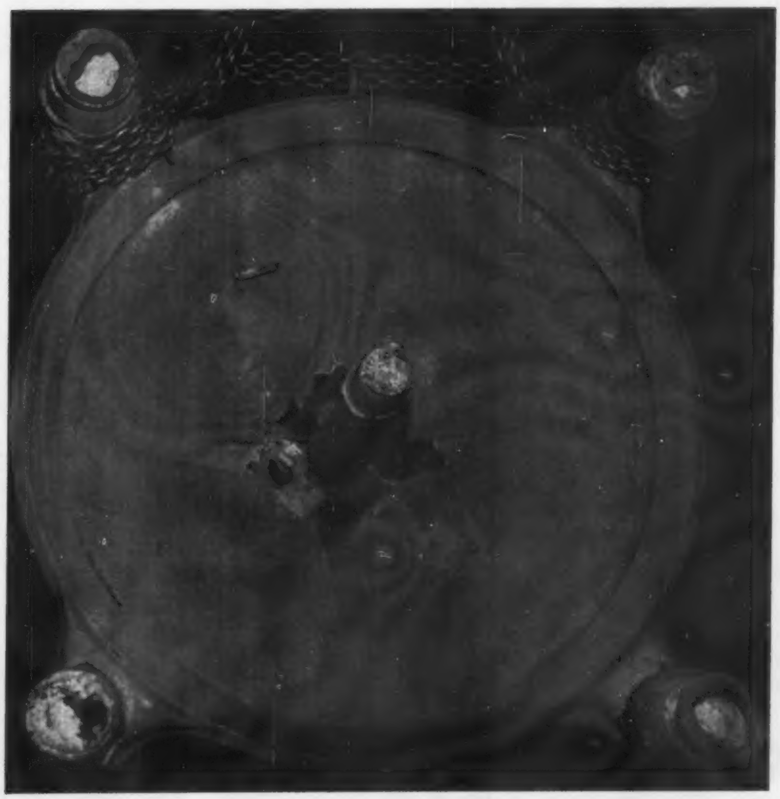
Important to the success of this operation is the use of exothermic materials in the risers. This creates the ideal thermal conditions: cold metal cooling quickly in the casting, hot metal cooling slowly in the risers. This practice too has resulted in an improved yield. Per cent of casting weight to metal melted is now about 58 per cent. This development while being principally a matter of mold preparation embodies consistent control of the melting technique and the pouring practice.

A casting made prior to use of olivine is kept on hand as a museum piece for purposes of comparison. This casting required hours of grinding and preparation to make a salable product. A casting made by today's modern practices has a finish that is salable without grinding.

An understanding of pouring rates, down sprue sizes, exothermic material influences, and proper mold preparation has paid off in a better casting at a more attractive price.

There is team work in this operation, evidence of think through and carry through that has put ideas into action, concepts into performance and performance into profits. Here is technology for profit.

Casting made prior to use of olivine. It is kept by Kensington Steel as a museum piece for comparative purposes. The casting required hours of grinding and preparation to make it salable. Note scabs, rat tails, and veins which spoil surface quality of the casting. Casting on opposite page results from new technology.



Roll shell after being shaken out. Gate and four exothermic risers are still attached. Similar casting (shown at left) has gates and risers burned off.

Value analysis is more than a vague concept, it is a workable plan that pares manufacturing costs to the bone. Increased competition, rising costs, and emphasis on quality control make this cost-saving technique essential for progressive metalcasters.

How Allis-Chalmers Saves Money Through Value Analysis

Special seminars bring together engineering groups, value analysis specialists, and suppliers to study specific products. This is a five-phase work plan that produces the necessary organized approach:

1. *Data gathering.*
2. *Speculative study.*
3. *Exploration and evaluation.*
4. *Planning and consulting.*
5. *Summarization.*

The usefulness of value analysis for every metalcaster cannot be shrugged off as an idea "not for me". It's worth study.

J. H. Snartemo
Value Analysis
Allis-Chalmers Mfg. Co.

Value analysis has been the subject of a great many dissertations and has been defined and described in many different ways. At Allis-Chalmers, value analysis is considered "an organized grouping of the various techniques that can be employed to eliminate unnecessary costs."

Although many of the individual product departments had been carrying on some excellent cost reduction work over the years, it was felt that a central value analysis section located in the purchasing division could add importantly in the areas of coordination. In addition, purchasing was the focal point for expert assistance and information available through suppliers.

Training people for value analysis work in each of the various groups and production areas was the initial task.

It was believed that a total of several hundred men would need training for the program to achieve any degree of permanent effectiveness. Further study tended to confirm this thinking during the next seven months.

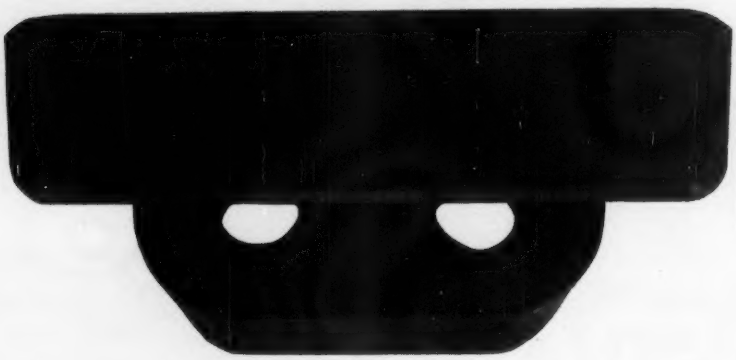
Seeking to avoid the delays and the "learning pains" that usually accompany self-teaching ("learning the hard way"), a firm of value analysis consultants was invited to make recommendations. Acting on their advice, a series of "tell-show-do" type training seminars was ar-

(*Continued on page 39*)

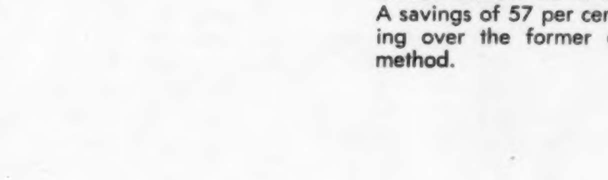
Larry Doyle, far left, Allis-Chalmers casting buyer, and team study a radiator valve. First step is determination of the basic and secondary functions of the part. Generally, 75 per cent of the cost accomplishes secondary functions.

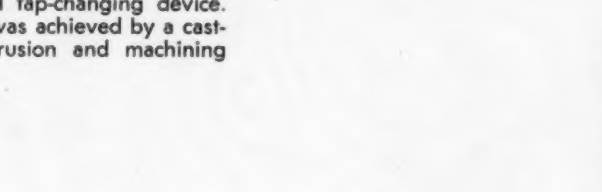
Bushing assembly gets thorough study by three-man team. Groups were challenged to remove at least 25 per cent of cost by "blast and refine" techniques, stripping the part to its essential function and then adding the necessary features.

A vital part of the program is participation by suppliers. Each of the study groups may request a conference with vendors invited to the session. This allows suppliers to be in on the initial planning stage and allows teams to draw upon the knowledge of outside personnel. Display shows typical castings. W. J. Pankratz, second from left, discusses casting possibilities with two team members.



Castings and extrusions, above and below, illustrate how savings can be effected by determining the basic function of the part, and then investigating how this could be done with another approach. Many poor values are the result of a lack of information, lack of imagination, or unwillingness to alter habits and attitudes. Effective value analysis must be accompanied by a willingness to change.





Typical of savings through value analysis is a bronze contact for a load tap-changing device. A savings of 57 per cent was achieved by a casting over the former extrusion and machining method.

ranged and the consulting firm was retained to conduct them.

The company's modern, air conditioned auditorium was reserved for each of the five week-long seminars. Trainees were selected by management and grouped into teams by the value analysis section.

Each team was made up of three or four men and included a supervisory engineer and product planner with the third (and sometimes fourth) man being from manufacturing, the purchasing department, standards department or some other staff function.

An actual production assembly or sub-assembly of a size that could be placed on a table for study was selected for each of the seminar teams.

Complete information was collected for these projects including drawings, annual usage, cost information and specifications prior to each seminar. Then, as seminar instructions proceeded, the study teams applied the various techniques of value analysis to their projects and learned that these techniques were effective when properly used.

Work Systematically

Because valuable leads can be overlooked if "shortcuts" are taken to obtain quick answers, stress was placed on the importance of proceeding through the work plan systematically and thoroughly. In other words, trainees were encouraged to work "by the numbers" both during the seminar and after. This "organized approach" or work plan can be outlined briefly as follows:

I. Information and data gathering phase (This phase, of course, was largely completed prior to the start of the seminar to save valuable time).

A. Obtain all the facts on the project being studied—drawings, costs, quantities, specifications, etc.

B. Learn the functions involved.

II. Speculative or idea gathering phase.

A. Consult with people familiar with the project.

B. Explore new materials, processes and equipment.

C. Conduct a creative session using a check list and brainstorming techniques.

III. Analytical phase—explore and evaluate all suggestions recorded in speculative phase.

A. Discussion session.

B. Weigh the good points of each suggestion against the bad—remembering the popularity of automobiles in spite of numerous "drawbacks."

C. Develop all ideas in proportion to their savings potential and probability of accomplishment.

D. Overcome objections based on personal prejudices, inertia or honest wrong beliefs outdated by advances in materials, processes and equipment.

IV. Planning phase.

A. Working within the company, determine most efficient manufacturing procedures.

B. Through the purchasing department, consult "specialty suppliers" for new approaches and/or standardized parts.

C. Select the ideas that, at this point, seem to offer the best value.

V. Summarizing for presentation phase.

A. For each of the suggestions finally selected in the planning phase, prepare a report to include sketches and complete cost data.

B. Prepare an over-all project report to include the reports for the individual suggestions and explanatory notes and data.

Suppliers played an important part in the training seminars just as they do in any successful ongoing value analysis program. From 18 to 25 suppliers attended each seminar, helping through displays, consultations, and quotations to provide answers to cost-reducing ideas and suggestions developed by the teams.

For example, in several instances teams suspected that costs of welded or fabricated parts were excessive and requested quotations on redesigned parts cast from iron, aluminum, bronze, etc. Usually, the casting supplier of the company foundry (depending on the size and type of casting that was involved) was able to offer substantial cost improvement.

In some cases, the original design had been developed only for prototype purposes and was never intended for production. In others, the various components of the assembly had been changed without any effort made to combine parts or simplify overall design. In any event, it was found that foundry products are often a key to worthwhile savings on many of our products.

Why Attitudes Changed

A most interesting aspect of the seminars was the change in attitudes that was so readily discernible as the sessions progressed.

Many of the trainees started with the idea that they had been taken away from more important work to sit in on a rehash of cost reduction emphasis lectures—such ideas, however, soon gave way in successive stages to surprise, enthusiasm and a sense of achievement as project after project was value analyzed and proved vulnerable to "the organized approach."

The final day of each seminar was devoted to a "wrap up" and presentation of the suggestions for the projects. Suggestions were written on forms provided for the purpose and charts were made on each team's accomplishments.

Open-house displays for management, which concluded each seminar, were enthusiastically received. Trainees went back to their respective work areas enthusiastic supporters of this fresh and stimulating program that so successfully attacks mounting costs—Value Analysis!

"Cloud Nine"—Permanent Mold Casting of Steel

Future foundry practices sometimes arrive as soon as tomorrow. Russians are now permanent molding steel box-type castings weighing several tons.
By eliminating individual deep cracks it is possible to get 250 and more castings with the same mold.

By S. I. SMOLENSKY, N. N. GUGLIN, G. F. ZASETSKY, A. K. PROVORNY, and V. A. TUTEV.

Translated by A. I. KRYNITSKY.

Permanent mold casting of steel may still be an idea ahead of its times. Nevertheless, Russian foundrymen are making inroads in the problems inherent to the challenge. Already success has been achieved in pouring large steel box-type castings weighing several tons.

The mold is made of steel and internal cavities are formed with sand cores. As a result of considerable research, mold life with steel molds has been improved so that it is superior to cast iron.

In this article the authors tell of establishing the optimum mold composition, wall thickness, ribbing practice, and heat treatments to achieve best service life when casting steel into steel permanent molds.

PERMANENT CASTING *of large* steel castings using steel molds is now underway in Russia. Cast iron molds were formerly used but were unsatisfactory because of the development of deep cracks.

These have been replaced by steel molds, and in the absence of deep individual cracks it is possible to make 250 or more castings per mold.

In the research project 14 molds, divided into five groups, were used. All molds, some of which had high sulfur content, were made of low carbon steel (0.06 to 0.14 per cent carbon). Both carbon and sulfur content are particularly important factors as far as the crack network is concerned. The crack network appears on the working surface of molds after 30 to 100 pourings.

In composition of molds, as sulfur is increased from 0.20 to 0.32 per cent, the number of pourings decreases almost 3-fold before cracks appear in the mold.

Beneficial effects of carbon content is particularly noticeable with an increase of sulfur content. Steel molds having sulfur content higher than 0.026 per cent and carbon raised from 0.10 to 0.14 per cent increases the number of pourings into the mold from 30 to 60 before the crack network develops. With low sulfur content, the influence of carbon is much less pronounced. However, the effect of increased carbon on the life of molds is beneficial.

Group 1 consists of molds 1, 4, 5, 6, and 9. The mold walls are of medium thickness (5.9 inches). They possess a medium rigidity (10 ribs) and their bottom is solid but not massive (3.9 inches).

Group 2 consists of molds 2 and 3. These molds have medium rigidity. Walls are of medium thickness and the bottom is removable. Molds of this type may expand freely in their lower part, this reduces the development of considerable internal stresses.

Group 3 consists of molds 7 and 8. Molds of this group have no ribs. Their walls are somewhat thinner (5.7 inches), the bottom is solid but not massive (2.8 inches). The rigidity of these is low with fewer areas where maximum internal stresses may originate.

Group 4 is represented by mold 10 which has a higher construction-

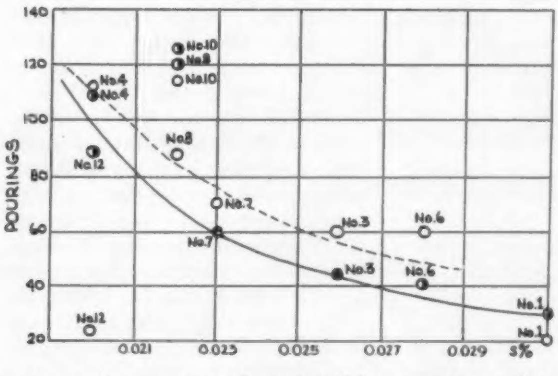


Fig. 1 Sulfur content of steel mold. Average number of pourings made between repairs of deep cracks shown by open circles. Number of pourings made before appearance of crack network shown by half open circles.

When sulfur increases from 0.20 to 0.32 per cent, the number of pourings before the appearance of cracks is decreased almost three times.

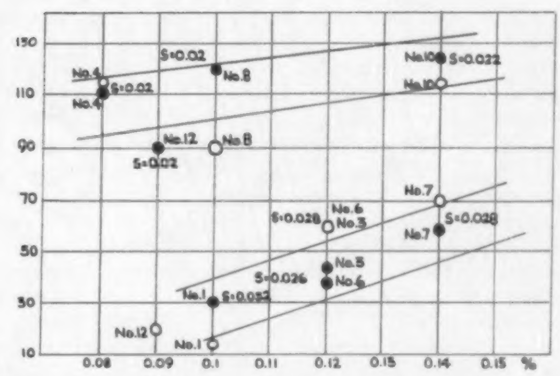


Fig. 2 Carbon content of steel mold. Number of pourings before appearance of crack network shown by solid circles. Number of pourings between repairs on account of deep cracks shown by open circles.

Beneficial effects of carbon is particularly noticeable with an increase in sulfur content.

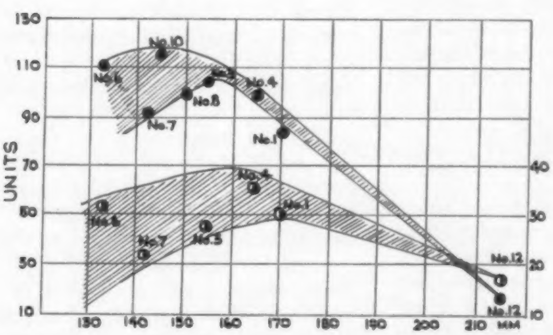


Fig. 3 Average wall thickness of mold. Conventional units proportional to number of pourings made before appearance of crack network shown by half open circles. Conventional units proportional to number of pourings between repairs on account of deep cracks shown by solid circles.

There is a definite relation between the resistance to the formation of the crack network and the resistance to development of deep cracks.

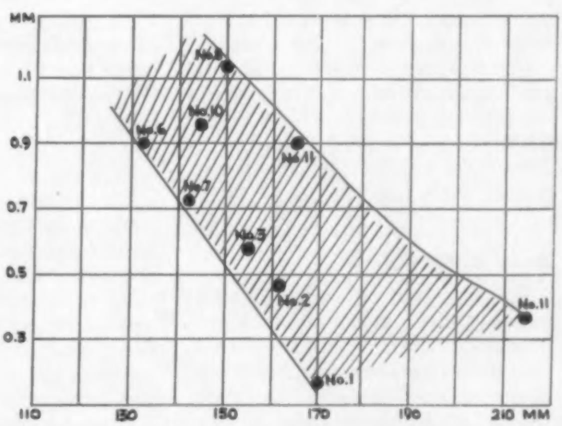


Fig. 4 Illustrates the relation between the magnitude of warping, occuring between the first 30 pourings, and the average wall thickness of molds at the belt located 7.9 inches from the flange.

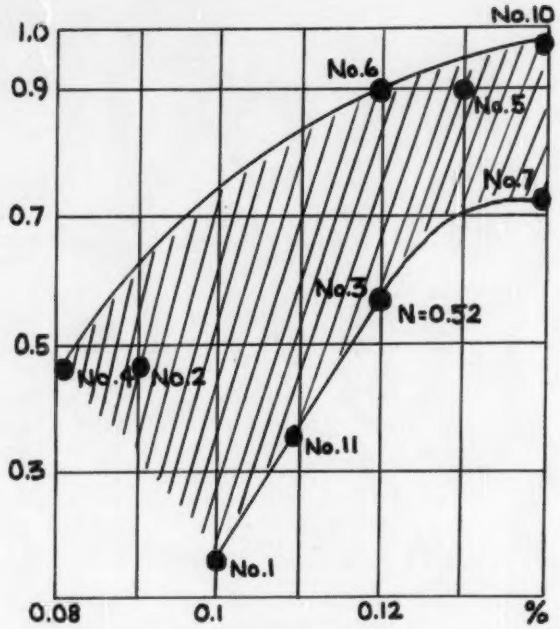


Fig. 5 Carbon content in steel of the mold showing warping after pouring first 30 castings.

Chemical composition has a definite effect on mold warping. There is an increase in warping with an increase in carbon over 0.11 per cent.

al rigidity (16 vertical ribs and 3 rows of horizontal ribs). The wall thickness is somewhat smaller (5.7 inches) and the bottom of the mold is not massive (3.9 inches).

Group 5, molds 11, 12, 13, and 14, have exceptionally high wall rigidity because of an 8.5 inch thickness. The bottom is solid with 20 vertical ribs. Thickness of the bottom, including ribs, is 17 inches.

Metal Molds Warp

Practice showed that metal molds of all construction types gradually become warped and that an erosion network developed on their working surfaces. In some places cracks were deep to the point of extending completely through the mold. The service life of molds were evaluated by:

1. The number of castings made in the mold before it had to be removed from service for repair of erosion cracks. (This characteristic is known as the life of metal mold).

2. The number of castings made in the mold before it was necessary to repair distortion of its original dimensions. (This characteristic is known as resistance to warping.)

Annealing of the molds is an important influence. The life of molds No. 8 and 10, which were subjected to an annealing operation, is longer than un-annealed molds containing approximately a similar per cent of sulfur.

Local overheating of the mold's working surface has a great effect on crack network formation. This network is first developed on areas close to the entrance of the liquid metal into the mold (near feeding head) and also on the surfaces adjacent to the massive parts of castings.

Considering the known influence of sulfur and carbon and eliminating the data obtained with annealed molds, the effect of wall thickness on the number of pourings made before appearance of a network may be presented as a function, the maximum of which corresponds to wall thickness of 5.9-6.7 inches.

Shortening the mold's life with a decrease in wall thickness below 5.9-6.7 inches is probably caused by an increase in the temperature of the mold's working surface. Increasing wall thickness probably shortens mold life as result of developing considerable internal stresses. Although the formation and growth of a crack network reduce the life of molds between necessary repairs they are, however, not the main causes of molds removal from service.

In the absence of individual deep cracks it is possible to make 250 and more castings with the same mold. An appearance of a crack network on a mold's surface does not put it out of service. When the crack's openings are small (0.16 inches) it is possible to obtain castings with satisfactory surfaces by using a heat insulating refractory coating.

Machine Larger Cracks

Larger cracks are machined, up to 1.2-1.6 inches deep, and welded. After that the molds may be re-used successfully for a long time. Deep and through individual cracks are the principal cause of periodic labor consuming repairs (machining and welding) and finally of their total rejection.

Development of such cracks depends also to a great extent upon the sulfur and carbon contents in steel molds as well as on their heat treatment. To a lesser degree it depends on the wall thickness of molds.

The data concerning the resistance of molds to the formation of deep cracks show a strong negative effect of sulfur and some positive influence of carbon. As to the constructional features of molds, their influence seems to be more upon the development of deep cracks than on formation of crack network.

Up to 5.9-6.1 inches mold wall thickness has little effect on formation of deep cracks. However, with a further increase in wall thickness, the number of pourings which can be made between repairs decreases and with wall thickness of about 8.7 inches it is very small. Thus, the number of pourings, obtained with mold 12 is around 10-29 and in some cases it dropped to 2-3.

It follows that there is a definite relation between the resistance to

the formation of the crack network and the resistance to the development of deep cracks. This indicates that there is a common cause for these defects.

Deep cracks are formed mainly at the bottom part of the mold in the areas opposite vertical ribs and make their way toward these ribs. This clearly confirms a negative effect of high mold rigidity on the formation of deep cracks since the ribs are the areas where internal stresses are concentrated. Thus, molds having no ribs withstood up to about 80 pourings between repairs.

The density of the mold's metal also has a pronounced effect on the deep cracks. Molds 1, 2 and 3 were cast bottom down. This metal had a lower density and mold life was short. Molds cast bottom up possessed better service properties.

It has been established in practice that the warping of molds of all groups, except group No. 5, occurs according to a certain regularity but with a different intensity. Most of the warping takes place during the initial period of service. Deep cracks and the crack network are evidently the contributing factors in retarding warping.

In view of the fact that the development of the crack network begins to show its effect on warping with an increase in the number of pourings, the influence of mold construction should be studied only on the basis of data obtained during the first period of mold service (up to 30 pourings).

Ribs Add Rigidity

Of the constructional elements, there were studied: Mold thickness in the zones of 7.9 and 19.7 inches below the flange, the number and height of rigidity ribs and the thickness of the bottom (with rigidity ribs). A higher warping was observed with molds without rigidity ribs or with those having few ribs of a small height.

Mold No. 10 was an exception. In spite of a larger number of high ribs, this mold was badly warped. Obviously two factors were responsible for this, i.e., a somewhat smaller wall thickness of this mold and its annealing. The most resistance to warping has been observed with the fifth group. Molds of this group had the largest number of large ribs.

The magnitude of warping occurred during the first 30 pourings, and the average wall thickness of molds at the belt located 7.9 inches from the flange. There is a sharp decrease in warping with an increase of wall thickness. The minimum warping has been observed with an average mold wall thickness around 6.1-6.7 inches.

As to the bottom thickness, no relation whatsoever between its thickness and the degree of warping has been noticed. However, it should be pointed out that mold No. 3, having a removable bottom, showed little warping.

Evidently, the possibility of free expansion of the lower part of molds has a beneficial effect on warping. The formation of deep and through cracks also sharply reduces the mold's tendency to warp. However, the development of such cracks leads toward a mold destruction and distorts badly the dimensions of its working cavity due to a wall displacement at these areas.

Chemical composition has a definite effect on mold warping. There is an increase in warping when carbon is increased over 0.11 per cent. An explanation may be advanced that an increase in strength itself has evidently little effect on the reduction of warping but it prevents development of the crack network which reduces warping. No effect of sulfur upon mold warping has been established. Thus, warping depends basically upon the rigidity of the mold; the greater the wall thickness, the more ribs present and the larger they are, the the smaller is the degree of warping.

Factors Affecting Mold Stability

The choice of a correct construction of molds and the selection of material is rather difficult since many factors having a beneficial effect on mold life show a negative influence on resistance to warping.

Evidently mold density has an effect on the development of deep cracks since the presence of shrinkage activities and sponginess assist the formation of deep cracks. Therefore foundry practice which insures the highest mold density is preferable.

The following technological factors also show their effect on both types of cracks:

1. Excessive heating of mold surface (poor coating).
2. Local heating (unsatisfactory method of feeding.)
3. Prolonged holding of mold at high temperatures (prolonged holding of casting in the mold, unsatisfactory method of mold cooling.)

Annealing of molds sharply increases their ability to withstand formation of a crack network and, to a small degree, to development of deep cracks. The most pronounced warping is observed during the first pourings. This intensity then decreases; with the appearance of a crack network and deep cracks it is sharply reduced.

Mold warping is reduced with an increase of wall thickness over 5.9-6.3 inches, and with a general increase in rigidity by an intense development of ribs. The sulfur content does not affect warping but there is an increase in warping with an increase in carbon.

Data indicate that the optimum parameters for securing maximum durability of permanent mold steel molds as follows:

1. A wall thickness of 5.9-6.7 inches.
2. A moderate number of small ribs or elimination of ribs.
3. A removable bottom of moderate thickness.
4. Use of steel containing not over 0.10 per cent carbon and 0.025 per cent sulfur.
5. Stabilizing heat treatment to relieve internal stresses.

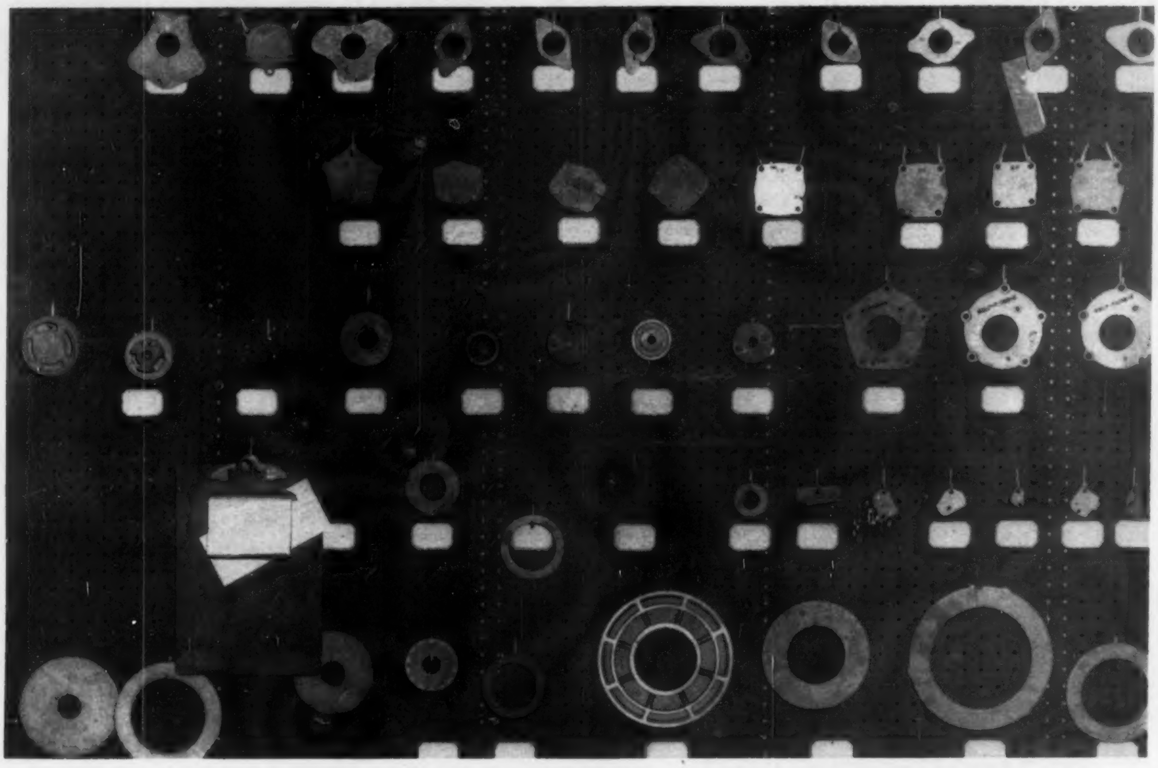


Fig. 1—Typical castings turned out at the rate of 1,000,000 monthly. Included are oil pump cover plates, camshaft thrust washers, clutch pressure plates and valve body covers. Expansion program has more than tripled foundry's capacity and reduced costs 30 per cent.

Modernization Slashes Costs, Castings Replace Stampings

Can you mass produce semi-precision, thin-walled castings in green sand? Sealed Power Corp. is doing this. Savings from new equipment and techniques will pay for $425,000 investment in 4-1/2 years. Much of the cut in production costs is made possible by special facilities which have drastically reduced machining expenses.

by JOHN VANHAVER, Foundry Manager, Sealed Power Corp., Muskegon, Mich.

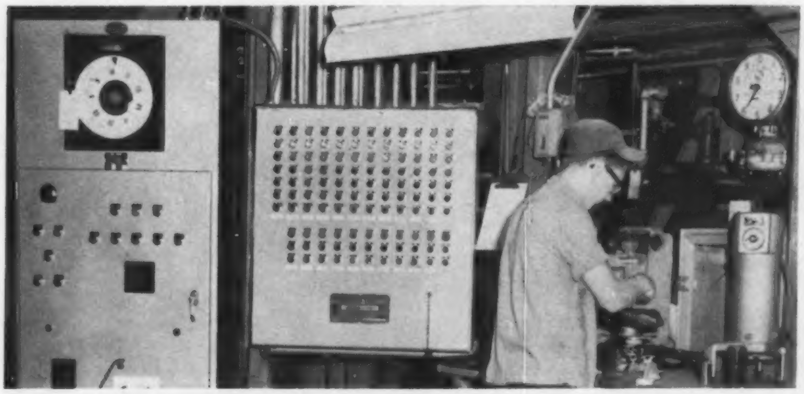


Fig. 2—Critical quality control measure requires an hourly testing of sand samples for composition and permeability. Sand is automatically distributed overhead to hoppers at 12 molding stations.

Fig. 3—Specially designed bottom squeeze molding machines are employed for high speed, high pressure service using the stack molding technique.

Competition has been met head on through modernization by Sealed Power Corp. New equipment and techniques, plus the latest in green sand molding methods, produces semi-precision, thin walled castings that are replacing stampings.

A 200 per cent improvement in productivity has netted a 30 per cent cost reduction. Savings through this program will allow amortization of the $425,000 investment within 4-1/2 years while operating one shift and only at 2/3 capacity.

Typical of the castings are engine and transmission oil pump cover plates, camshaft thrust washers, clutch pressure plates, and valve body cover plates. Castings like these can be produced at the rate of 1,000,000 per month.

The plates are cast with such accuracy that only 0.025-inch grinding stock is allowed. Hole centers are as-cast to ±0.010 inch. The holes are formed by the green sand mold, not by cores. Draft measures only 1/2 to 3 degrees. A sizeable savings in machining contributes materially to cost reduction.

Good quality wear resistant iron is prepared in a low frequency 4000-pound 700 KW coreless induction furnace. Melting rate is 1.4 tons per hour. Approximate analysis of the metal equals—3.80% C, 2.90% Si, 0.55% Mn, 0.45% P, 0.04% S and 0.20% Cr.

Precision green sand molding starts with the mix formulation and conditioning techniques. Sealed Power uses a semi-synthetic mix containing a silica sand with AFS 100 grain fineness number, 9-10 per cent clay, and 3.6 per cent moisture. The system sand makes a round trip about every two hours so cooling it represents an important consideration. Sand enters the muller at about 220 F and is cooled to 115 F by blowing air through it for 32 seconds.

Mixing is automated and moisture content is accu-

rately controlled electronically. Sand quality control is so critical that a sand testing station is located immediately adjacent to the muller. Sand samples are taken from the muller every 15 minutes and tested for green strength, permeability and moisture.

Because of the very specialized nature of their production, Sealed Power designed its own bottom squeeze molding machines for high speed high pressure service. Thin flat castings, like piston rings and cover plates, require thin molds so stack-molding proved to be a natural approach to efficient production.

Fig. 4—Bowl-shaped retainer on molding machine catches overflow and spill sand. Sprue cutter in head automatically cuts sprue in center of the mold.

How pattern plate sticking is reduced

Pattern plates are precision-machined from bronze and heated electrically to about 115 F to negate sticking tendencies normally accompanying use of hot sand. Besides good heat conductivity bronze also gives a clean draw from green sand molds. A maximum number of duplicate patterns are mounted symmetrically and peripherally around a central sprue hole.

When the pattern is locked on the molding machine it is completely surrounded by a bowl shaped retainer to catch overflow and spill sand. This innovation was necessary because there was no space available for an underflow return belt system for spill sand. By catching the sand in the bowl no valuable time need be wasted on shovelling spill sand off the floor.

An aluminum frame with self aligning locating ears on opposite sides serves as the flask for stack mold sections. Sand drops from overhead onto a riddle by opening chop gate on hopper. The pattern is first faced with riddled sand. Then the sand which has accumulated in the bowl is quickly scooped by hand into the flask until filled. Flask is struck off and molding machine head is lowered onto top face of mold. A sprue cutter mounted in this head automatically cuts the sprue in center of mold.

Pneumatic squeeze pressure (85-125 psi) is exerted upward on pattern pushing it 7/8 of an inch into the sand. This squeeze produces an 88-92 mold surface hardness. When pressure is released the exhaust from squeeze cylinder of molding machine is directed through a pipe so that it blows loose sand off top of mold section before next layer is set down. Next, the mold section is manually lifted from the pattern and set on top of the mold stack. Two grooved guide posts facilitate speedy stacking of 26 mold sections on each pallet car.

The speed and efficiency of this well designed molding system is proven by the output of 1350 mold sections per man per shift. As soon as a stack is completed it is poured. Molds then set for specified times ranging from 30 minutes to 3 hours in order to develop optimum physical properties.

Shakeout machines

Ingenious shakeout machines have been custom designed to handle a complete stack of molds. Stack molds are hoisted and positioned between two "hugging arms" which hold the flasks. Vibrating action of the shakeout grid loosens sand from the flasks and castings. Sand drops into conveyor leading back to sand conditioning system.

A clamp holds onto the sprue while vibrating action shears the castings off at the point of contact with the knife-gates. Castings slide to back of machine and into a collection barrel. Sprue is deposited in another barrel and returned to melting department. And flasks travel on roller pallet to molding stations.

Gordon E. Reynolds, vice president of manufacturing, explains that "this foundry expansion program will more than triple our capacity for semi-precision plates, large rings and miscellaneous castings . . . and will provide greater flexibility in our foundry."

Fig. 5—Special innovations for speeding production and improving quality include pipe in center for blowing foreign matter off the top layer, and two grooved pipes to allow speedy stacking.

Fig. 6—Custom-designed shakeout machines speed operations through use of "hugging arms" which allow handling of complete stack of molds at one time. This expedites production.

Fig. 7—Looking down on molding station and flow line from catwalk. Man in left background is making a time study of operations. Notice how stack mold flasks move to molding stations on elevated pallet conveyors, molds are made, stacked, and then moved on floor-level pallet.

Farm Mechanization Growth Expanding Market for Castings

1. *Sales expected to be greater in 1961 as compared to last year. Survey of farm equipment leaders indicates need for better quality parts at lower cost.*

2. *More than 800,000 tons of metalcastings now being used by farm equipment manufacturers today. Included are gray iron, ductile iron, malleable iron, steel, aluminum, brass, and bronze.*

3. *New market opportunities for metalcasters also being created by diversification plans. Farm equipment makers going into other fields such as road building, logging, and materials handling.*

4. *Metalcasters have chance to increase profits. But they must move now and provide new and improved products.*

An upsurge in farm mechanization is creating new markets for metalcasters today. Sales prospects are bright because gross farm income has developed a market which now exceeds more than $2 billion annually. To build farm equipment, manufacturers need castings. How much?

1. More than 800,000 tons of gray, malleable, and ductile iron.
2. More than 50,000 tons of steel castings.
3. More than 7000 tons of aluminum castings.
4. More than 2000 tons of brass and bronze castings.

Proof of the importance of castings in building tools for agriculture is demonstrated by the large number of manufacturers owning their own foundries. Of 36 farm equipment builders 16 own and operate over 30 foundries. Operation of captive foundries proves the need of large quantities of reliable quality cast components.

Most of the tractor and implement builders produce their own gray iron castings. Some have malleable iron facilities. Lately ductile iron production has been undertaken. Close to 45 per cent of the castings in these three categories are produced in foundries owned by farm equipment manufacturers.

International Harvester Co., for instance operates five foundries and is currently in the process of modernizing its Memphis foundry to produce nothing but ductile iron castings. In the past year Deere & Co. has installed a completely automated green sand molding department in one foundry, built a ductile iron foundry, and modernized its Waterloo foundry.

Optimistic confidence in the future use of castings in farm equipment and implements is reflected in these several isolated examples of growth in casting capabilities. There are still considerable quantities of castings purchased from jobbing foundries in areas where they can produce competitively.

Industry leaders are looking to improved sales of equipment in 1961. The year 1960 was hampered

by unstable conditions on the farm scene, a late wet spring, and politics. International Harvester's president, Frank W. Jenks, commented recently, "The retail farm equipment market this fall has been somewhat improved. There has also been an upward trend in gross farm income, as a result of improved hog prices, generally steady cattle prices, and an improved cotton situation. It is not likely that we will have a recurrence of the very adverse weather conditions which hampered selling in early 1960. For these reasons, it seems reasonable to expect that there will be a moderate improvement in our 1961 farm equipment business."

A new emphasis on diesel powered tractors for economy plus power is opening new markets in heavy industries. New models are suited for logging, earthmoving, and materials handling.

Farm productivity is still being upped by "bigness." The latest behemoth is a 7-ton self-propelled combine capable of cutting a 22 foot swath.

Farm implements are literally loaded with castings to meet the rugged torture of rough terrain, long hours of gruelling service, extremes of heat and cold, heavy over-loading, dusty environments, abrasive surfaces, and brutal manhandling. One manufacturer estimates 15-20 per cent of his implements are made of cast components while tractors use as much as 30 per cent.

A sample of castings used in farm equipment would include:

Corn picker snapping rolls
Hydraulic valve bodies
Cylinder blocks
Motor grader bolsters
Cylinder heads
Wheels
Wheel discs
Covers
Engine Blocks
Bearing blocks
Oil Pans
Bearings
Engine accessory housings
Boot assemblies
Power train component housings
Corn planter plates
Hydraulic cylinder heads
Brackets
Hydraulic lift arms
Differential carriers
Scarifiers
Rocker arms
Axle extrusions spindles
Hydraulic ram anchors
Gear cases
Cotton-stripper teeth
Brake Shoes
Hay hammers
Wheel spiders
Drive shaft nuts.

Here's why the farm equipment

Quality castings serve many vital functions on farm equipment and tractors in rugged applications like that shown below. As a result farmers have increased their productivity 67 per cent in the past decade.

industry prefers to use metalcastings:

1. Low cost of cast materials,
2. Broad range of physical properties available,
3. Flexibility of castable designs,
4. Ease of production,
5. Ability to cast intricate configurations,
6. Excellent surface finish and dimensional accuracies in as-cast condition,
7. Important fabricating properties such as machinability and weldability,
8. Certain inherent properties such as ductility, weight, and bearing characteristics.

Cast materials include gray iron, malleable iron, ductile iron, steel, aluminum, bronze, and stainless steel; also nonferrous die castings.

Gray iron is generally used where weight and good machinability are desired at minimum cost.

Pearlitic malleable iron finds application where high strength and elasticity in reduced cross sections are a design requirement.

Ductile iron is often substituted for steel or pearlitic malleable in applications when the cost proves lower.

One user suggests, "Manganese bronze is a substitute for malleable iron for fast delivery and to expedite testing with an equivalent material."

Steel castings replace steel forgings when possible as a cost cutting measure.

Die casting is ideal for applications where minimum machining and detail of configuration are paramount—as in the case of hydraulic valve bodies.

If foundrymen want to enlarge their share of the components comprising tomorrow's farm equipment they must meet today's demands for better quality at lower price.

For metal castings to be more competitive with other materials and processes they must meet current demands for:

1. Lower cost per piece
2. Better physical properties
3. Reliability
4. Closer tolerances
5. Improved machinability
6. Shorter lead time (from date of order to delivery)
7. Better cleaning and grinding of castings.

Evidence of these improvements must be presented to customers. More time needs to be spent with designers educating them to the "new look" in metalcastings. They need foundrymen's assistance. Keep them informed on new specifications and casting technology that may affect their design planning.

When castings lose ground to other competition, foundrymen should ask "why?"; then improve their product and practices accordingly. Reflecting this thinking, D. J. Wright, Caterpillar Tractor Co., says, "Although the field performance of cast metals in our product has been generally satisfactory, the people concerned with the choice of materials to be used are tending to turn away from castings because of:

1. Excessive inspection cost to assure soundness and reliability (five times higher than for forgings for example);
2. Too many near-disasters in field performance when important castings were presumed to be reliable and at the last minute found not to be;
3. Heavy losses in machining time and cost from serious defects showing up after machining is nearly completed;
4. A casual attitude of some foundries toward the degree of soundness and uniformity to be expected in castings. The tangible result is a slight but steady decrease in the proportion of cast metals used in the product."

Weldability of cast materials is becoming increasingly important as designers plan in terms of weld assemblies involving dissimilar metal segments shaped by diverse fabricating techniques.

With farm mechanization far from the saturation point . . . with the trend toward bigger farms and less labor . . . with new equipment obsoleting the old at a rapid pace . . . with rugged service leading to a short life expectancy for agricultural equipment . . . and faced with a prosperous 1961, foundrymen should make every effort to get a bigger piece of this farm equipment business.

A Special Report

by Jack H. Schaum

Assisted by:

A. W. Acker, Chief Engineer, Henry Mfg. Co., Inc., Topeka, Kan.

R. E. Heikes, Vice Pres. & Dir. of Production, Dempster Mill Mfg. Co., Beatrice, Neb.

M. H. Horton, Materials Engineering Deere & Co., Moline, Ill.

G. T. Kalman, Asst. Staff Industrial Engineer, The DeLaval Separator Co., Poughkeepsie, N. Y.

G. C. Joynt, General Mfg. Manager, Tractor & Implement Div., Ford Motor Co., Birmingham, Mich.

C. E. Maddick, Gen. Quality Control Mgr., Massey-Ferguson, Ltd., Toronto, Canada

R. R. Raney, Director of Engineering & Research, New Idea Equipment Co., Coldwater, Ohio

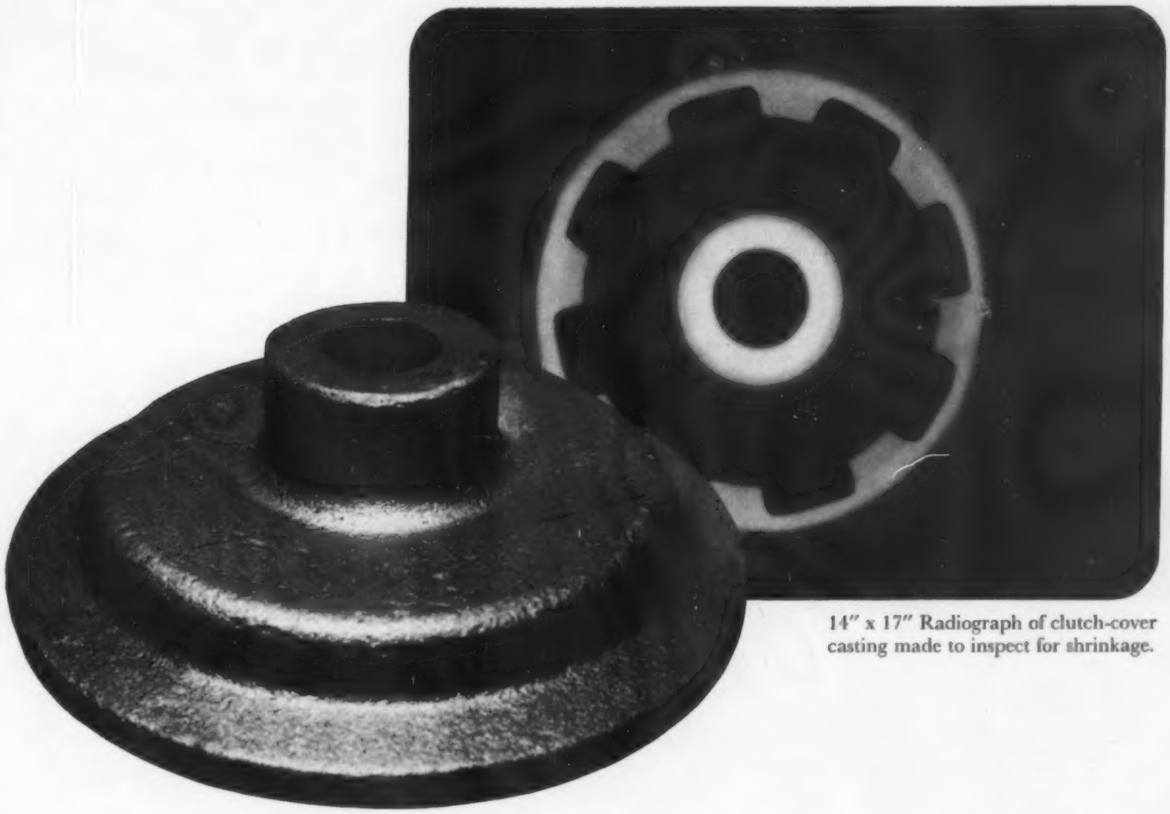
R. L. Ressler, Vice-President, New Holland Machine Co., New Holland, Pa.

F. C. Roll, Factory Supt., R. Herschel Mfg., Co., Inc., Peoria, Ill.

J. H. Willson, Pres., Athens Plow Co., Inc., Athens, Tenn.

D. J. Wright, Manager Quality Control General Office, Caterpillar Tractor Co., Peoria, Ill.

A. Zanotti, Foundry Engineer, Oliver Corporation, Charles City, Iowa



14" x 17" Radiograph of clutch-cover casting made to inspect for shrinkage.

The grip that moves mountains must not be broken

Clutches on heavy earth-moving equipment must literally grip with a cast-steel hand. Riverside Foundry, Bettendorf, Iowa, checks the reliability of its clutch-cover castings with radiography.

One of Riverside Foundry's customers makes huge and powerful earth-moving vehicles. Every part must contribute to their stamina—especially the parts that handle the hundreds of horsepower that drive them.

In order to make sure that the castings they deliver are sound and ready for this demanding job, Riverside Foundry of Bettendorf, Iowa, radiographs them, using Kodak Industrial X-ray Film.

This is one of the ways foundries, large and small, are today making certain only high-quality work goes to their customers. They find radiography helps build their reputations and their business.

Radiography can work profitably for you. How? Talk it over with an x-ray dealer or write for a Kodak Technical Representative to call.

NOW . . .
in the NEW Ready Pack . . .
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Circle No. 151, Pages 145-146

What Is Your Safety IQ?

Foundries in particular need considerable improvement in their safety programs. How well do you know foundry safety fundamentals? Take this test and see. Be careful, because the questions involve thought. Carefully study the wording of each statement.

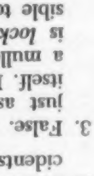
1. The same safety slogan should be kept in a prominent place for at least six months in order to drive the message home. T ☐ F ☐
2. The principal cause of accidents is unsafe conditions. T ☐ F ☐
3. The plow on a sand muller should be equipped with a guard to protect maintenance men working inside the muller because the muller may be started accidentally. T ☐ F ☐
4. Before adding pig metal to a crucible of molten metal, the pig should be heated for at least twenty minutes to prevent explosion. T ☐ F ☐
5. When working under a ladle of molten metal suspended by a crane, a workman should wear protective clothing in case of metal splash. T ☐ F ☐
6. If safety goggles are not available in a foundry ordinary reading glasses or sun glasses are better than none at all. T ☐ F ☐
7. The primary responsibility for accident prevention rests with the president of a company. T ☐ F ☐
8. In a foundry, burns are the most frequent type of injury. T ☐ F ☐
9. If the number of injuries in a foundry is lower than it was the previous year it is proof that the safety program has been more effective. T ☐ F ☐
10. A foundry with a low severity rate and a high frequency rate, has a more effective safety program than one with a high severity rate and a low frequency rate. T ☐ F ☐

Give yourself 10 points for every correct answer, shown upside down on the adjoining column.

If you scored 100, you are a safety expert and have probably studied the AFS SAFETY MANUAL.

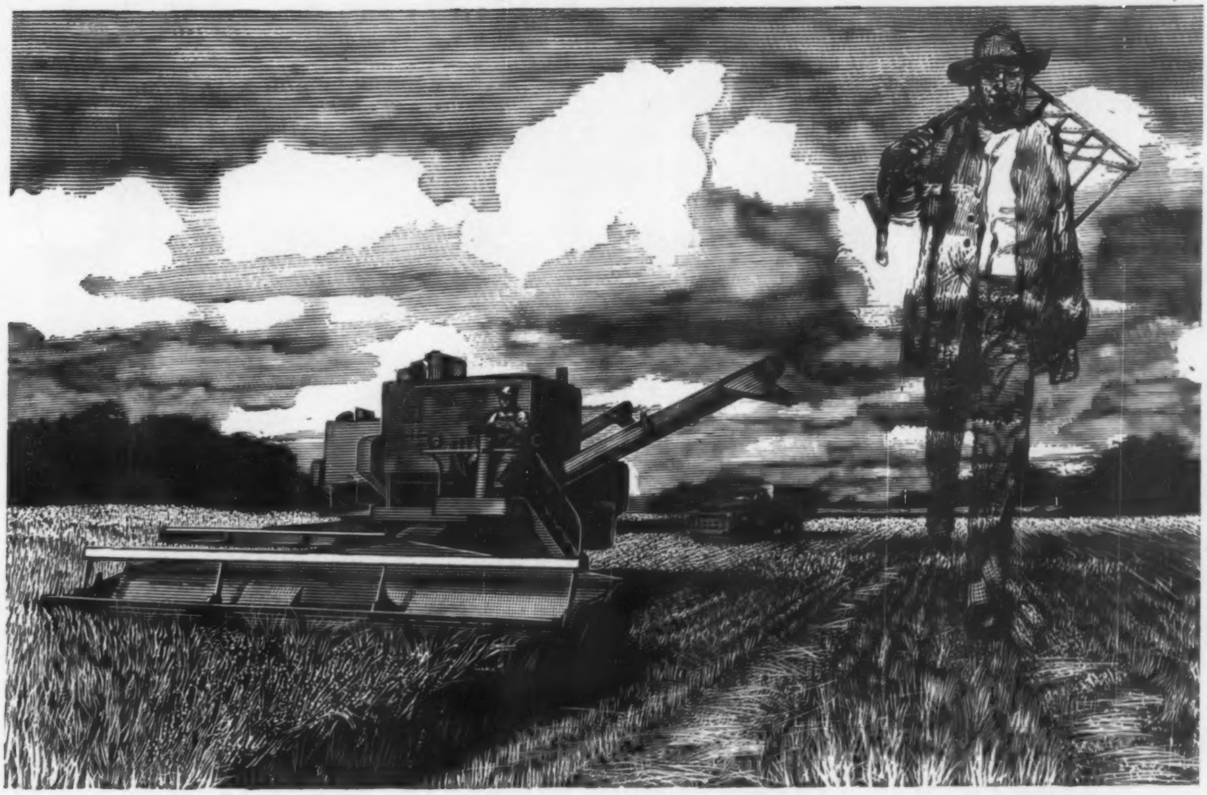
If you scored 50, you have an average knowledge of safety and need further instruction.

If you scored zero, it's an accident that you aren't in the hospital or dead.



Answers to Safety Test

1. False. A slogan used for too long a period gradually loses its effect. It is better to change slogans weekly or monthly to stimulate interest and create a new safety impact.
2. False. The principal cause of accidents is unsafe acts.
3. False. A guard on the plow is just as dangerous as the plow itself. No one should work inside a muller unless the main switch is *locked* out making it impossible to operate the machine.
4. False. Pig metal should never be added directly to molten metal because the pores may contain moisture. No one can guarantee that in twenty minutes or in any other period of preheating, moisture has been completely driven out.
5. False. No one should ever work under a suspended load of molten metal or of anything else.
6. False. Ordinary reading glasses or sun glasses are more dangerous than none at all because of the violence of shatter on impact. There is more danger of eye injury with them than without them. No one should ever be in a foundry whether worker or visitor without using either safety glasses, safety goggles or safety eye shields.
7. False. The primary responsibility rests with the foreman. The president delegates authority to the foreman for the conduct of all phases of his departmental work. All authority entails correlative responsibility.
8. False. Being struck by, or striking against, objects occurs more frequently.
9. False. It is pure chance that an *injury* results from an accident. The statement would be true if the number of *accidents* were lower.
10. False. The severity of an injury is the result of pure chance. In the long run, the foundry with a high frequency rate will also have a high severity rate; and the foundry with a low frequency rate will eventually have a low severity rate.



Progress in metals . . . a key to America's bountiful breadbasket

A revolution occurred in American agriculture when industry began fashioning farm implements largely from iron and steel. Giant metal combines began harvesting a hundred acres of wheat far faster than a dozen farm hands could harvest a single acre. Today, the farmer's ability to wrest more and better foods and fibers from the soil has again increased many fold over just a few short decades ago. And again, largely due to modern farm machinery made more rugged and dependable by improved gray iron castings and higher strength steels.

Pittsburgh Coke & Chemical Company, through its Coke & Iron Division, is one of the nation's leading merchant producers of high quality metallurgical coke and pig iron for the gray iron foundry industry—and of ferromanganese, an indispensable alloy in every ton of steel the nation produces.

The Coke & Iron Division is one of four service-conscious subsidiary organizations of Pittsburgh Coke & Chemical Company—a basic producer dedicated to help your company produce *a better product . . . at a better profit.*

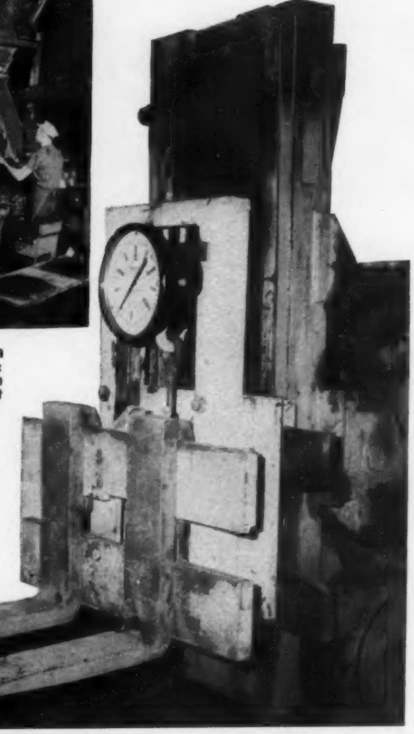
COKE & IRON DIVISION

PITTSBURGH COKE & CHEMICAL CO.

GRANT BUILDING • PITTSBURGH 19, PA.

Circle No. 152, Pages 145-146

View of Gray Iron Pallet System. Pallets can be easily moved over rails by hand. Left: Plant Engineer Robert H. Clarke. Right: Scale mounted on fork truck weighs each component of charge.



ENGINEERING APPLICATIONS PAY OFF AT DALTON FOUNDRIES

INCREASED EFFICIENCY To obtain faster, more efficient, production in the company's gray iron foundry, Robert H. Clarke, Plant Engineer at Dalton Foundries, Inc., Warsaw, Indiana, designed a pallet system. This flexible system allows molders to work two hours before pouring needs to begin. Cooling time can be varied to suit the job and pallets can be easily moved over rails by hand. No bottom boards are used and the handling formerly required to bring them back to the molders has been eliminated. The pallet system provides flexibility for both production and jobbing type work.

BETTER CONTROL When bond and water are added to sand during mulling, the bond must be thoroughly combinded with water to be effective. Plant Engineer Clarke designed a system to pre-mix water and bond, and pump the mixture into a storage tank where it is stirred continually. From the storage tank, small amounts of the mixture are metered into a tank by a timer. Compressed air then blows this metered amount into the muller at the correct time. This system has resulted in better control of sand, faster mulling cycles, and easier handling of materials.

LOWER COST At the Dalton Foundries the old wheelbarrow method used to charge the cupola required seven men. Clarke designed a scale which could be mounted on the front of a fork truck to weigh each component of the charge as it was loaded into a drop-bottom tub on the truck. After it is loaded, the fork truck delivers the material to the charging bucket. This simple, and inexpensive engineering change reduced the labor requirement to three men instead of the seven previously required.

You can help create a source of engineering talent for the foundry industry by participating in the FEF program as a contributing member.

Foundry Educational Foundation

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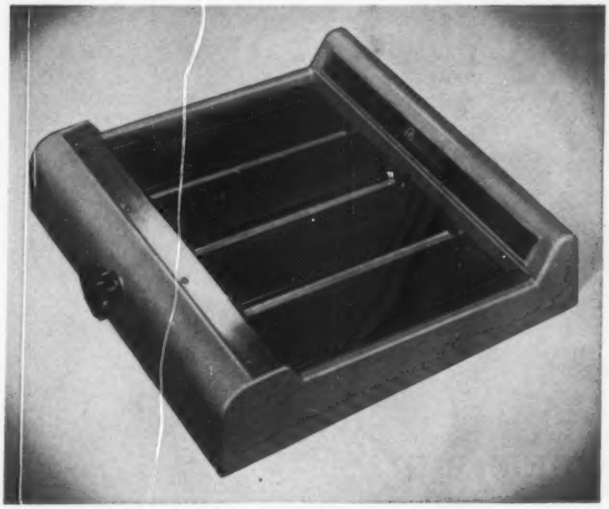
Space contributed by **Modern Castings** as another service to the metal castings industry.



1470 AB

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Individual elevated hard glass grinding surfaces are continually flushed with streams of water. This floats off the surface removal products, provides lubrication, and leaves sharp abrasive edges exposed at all times. A control valve permits complete selectivity of the volume of water. Ample drainage facilities with standard pipe fittings are provided at the rear. The grinding platforms are pitched downward and away from the operator.

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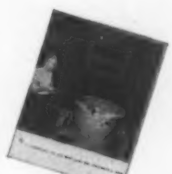

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S. C. Massari

Castings Congress Papers

New areas are unfolding for foundrymen. A vital role can be played in the aircraft industry if critical standards are met. Lightweight, cellular material opens additional opportunities as does the weldability of Ni-Al bronzes. Cheaper, faster, core and mold production is promised by the hot core box process. A study of the mulling effect presents practical uses.

TECHNICAL HIGHLIGHTS

Lightweight Cellular Material 57
Production of cellular metal castings to closely controlled tolerances opens new commercial possibilities. The process permits not only control of cell size but also cell geometry and distribution. It overcomes many of the limitations of previous methods. Molds are prepared with standard practices and filled with crushed rock salt and then packed by vibration. The mold is heated, metal poured, metal-salt composite casting shaken out, and salt crystals leached out leaving cellular cavity. Investigation has been conducted with aluminum, but it appears to be applicable to any metal having a lower melting point than sodium chloride. Suggested applications are metallic filters, exhaust muffler elements, bearing materials, sandwich core material, jigs and fixtures, energy absorption material, heat transfer, electrochemical processes, and electronic packing systems.

Weldable As-Cast Ni-Al Bronze 73
Addition of good weldability characteristics to the already good mechanical properties and excellent cavitation resistance greatly increases the potentials of Ni-Al bronzes for propeller castings. Investigation shows, that in general, as the aluminum content increases, the strength and hardness tend to increase while the elongation decreases. An aluminum content of approximately 9 to 11 per cent imparts good hot ductility properties necessary for welding.

Effect of Mulling in Sand System 95
Production of high-quality castings depends upon strict control methods. One of the major obstacles in sand design and control are the variables present in mulling operations. Many factors in the cycle itself accentuate and compound the variables. The investigation deals with the effects of mulling on the physical properties of simple sand-clay-water systems. The clays investigated were western and southern bentonite and fireclay. Application of principles in this investigation will aid foundrymen in choosing the most economical combination of mulling equipment, clay type and content, and working water range.

Challenge from Aircraft Field 111
A challenge has been issued to the metalcasting industry by the aircraft industry to play a part in the nation's future. The role depends largely on the ability of foundries to produce high strength-to-weight castings in which every ounce contains the anticipated values. Seven design rules are advanced for the production of smooth as-cast surface with minimum weight and costs. Good steel aircraft quality castings must possess the required castability characteristics and uniform stress distribution while in application.

Hot Core Box Fundamentals 116
Cheaper, faster, core and mold production results with the hot core box process. Several basic factors must be considered: attention is needed in all production factors; good sand condition is essential; some modifications may be necessary in coring procedures. In a proper application, highly satisfactory results are obtained.

The technical articles appearing in this preview section of MODERN CASTINGS are the official 1961 Castings Congress Papers. Nearly 100 technical papers are scheduled for presentation at the 65th Castings Congress to be held May 8-12 in San Francisco. Readers planning to participate in oral dicsussion of these papers during the Castings Congress are advised to bring them to the technical sessions for ready reference. Written discussion of these papers is welcomed and will be included in the 1961 AFS TRANSACTIONS. Discussions should be submitted to the Technical Department, American Foundrymen's Society, Gulf and Wolf Roads, Des Plaines, Ill.

LIGHTWEIGHT CELLULAR METAL

by L. Polonsky, S. Lipson and H. Markus

ABSTRACT

A process for the production of cellular metals is described. The process consists of preparing a refractory mold, filling the mold with soluble granules which correspond to the size and shape of the pores desired in the metal and infiltrating the molten metal into this soluble aggregate. After leaching with a suitable solvent, the metal has a void structure of interconnecting cells which correspond to the shape and size of the soluble aggregate. The apparent density of the metal body can be controlled from a maximum of approximately one-third of its base density to some lower density in the order of one-fifth the base density.

In addition to process development, which includes casting of shapes as well as billets, a limited investigation of the mechanical characteristics of aluminum-base cellular metal was made. Potential applications for materials of this type are suggested.

INTRODUCTION

The development of foamed plastics and their application as materials of construction have lent a certain impetus to the development of similar metal base material. The first successful attempt to produce an aluminum foam was the result of an Air Force contract with the Bjorksten Research Laboratories, Inc.[1,2] The method used was similar to that employed for plastic foams in that a gas forming component was added to the molten aluminum alloy.

The first efforts were with the aluminum-magnesium eutectic composition (55 per cent Mg-45 per cent Al) with either zirconium or titanium hydride dispersed through the melt as the foaming agent. This produced a metallic foam which had a specific gravity of 0.5 to 0.6 (gm/cc) with a void volume of approximately 75 per cent of the specimen volume. Another process for the production of porous metal products was developed by Armour Research Foundation.[3] This is called film metallurgy, and the material, which is produced by a felting process, is sintered in much the same manner as is done with metal powder products.

While these newly developed materials had many desirable characteristics, they suffered from certain limitations insofar as the specific Ordnance applications which were then being considered for materials of this type. In an effort to develop a material more nearly suited to these specific applications, a radical departure was made from the foaming principle. The material produced as a result of this new process was called cellulâr aluminum rather than foamed aluminum, since foaming played no part in the method of production.

Briefly, in this process use is made of a refractory mold which is filled with graded soluble granules. The alloy is infiltrated throughout the compact by methods which are discussed later in this report. After solidification, the soluble granules are leached out of the structure, leaving a cellular metal structure which has a void volume of approximately 70 per cent.

Preliminary tests showed that this method was feasible. The interconnecting nature of the voids was an interesting characteristic, and suggested a variety of other possible applications as an ordnance material. This report is a description of processing techniques developed to produce cellular aluminum and other metals, as well as a limited evaluation of mechanical and physical properties of the material.

MATERIALS AND METHODS

Description of General Process

Cellular metal is produced by a foundry process. Molds are prepared according to standard practice. Once prepared, the molds are filled with a suitable grade of soluble granules. Since substantially all of the work described in this report deals with metals having casting temperatures no higher than that of aluminum, the soluble granules used were graded crushed rock salt. In filling the mold, the particles tend to pack in the most effective manner permitted by the particle shape.

Vibration is used to promote this packing. Since none of the particles can remain suspended in space, each particle must contact at least one other neighboring particle. In practice, all of the particles touch many adjoining particles.

The mold is then heated in preparation for infiltration by the molten metal. During the heating cycle mold moisture is vaporized and small amounts are condensed on the surface of the granules. This provides a liquid binder for the particles. Upon

L. POLONSKY and S. LIPSON are Met. and H. MARKUS is Dir. of the Met. Rsch. Lab., Pitman-Dunn Laboratories, Frankford Arsenal, Philadelphia, Pa.

further heating, the liquid is evaporated, and the salt, crystallizing from solution, welds the particles together at the points of junction. The mold cavity, at this point, contains a coherent salt briquette. The spaces between the particles are eventually filled with the metal which forms the cellular structure. Figure 1 shows part of a salt briquette which was removed from a mold after it had been heated to the casting temperature.

Fig. 1 — Salt compact.

The metal is now melted, brought up to its pouring temperature, and poured into the salt-filled mold. By methods which are described later, the molten metal is infiltrated into the spaces between the salt particles and, once in place, is permitted to solidify. The casting may now be shaken out of the mold and is ready for any necessary machining. The casting is a composite material, one component being the salt briquette and the other the metal infiltrant. The cellular metal structure is exposed by leaching away the salt crystals from the metal-salt composite.

The product may be regarded now as a negative of the porous type structure obtained by powder metallurgy. The metal component may be compared to the void component of the powder metal compact, and, conversely, the void component to the metal component of the powder metal product.

It may be seen that this process permits control not only of void or cell size, but also of cell geometry and size distribution. Figure 2 shows a range of cell sizes produced by this process. The details of accomplishing the steps outlined above are described in this report.

Soluble Granules

Ideally, the soluble material used for making cellular metal should be a high-melting point salt of high-aqueous solubility, noncorrosive to the metal infiltrant, stable, nonhygroscopic, readily available, and inexpensive. Since this investigation primarily pertained to the production of aluminum alloys in cellular form, a salt had to be selected to fulfill the requirements as related to these alloys. A review of potentially suitable materials quickly disclosed that sodium chloride fully satisfied most of these requirements.

In fact, the only serious limitation was the corrosive nature of sodium chloride brines. Although reference data revealed several other promising salts, on the basis of the criteria mentioned above sodium chloride was selected as it was far superior to all those considered.

The salt used in this work was a commercial grade which is 99 + per cent sodium chloride with insolubles limited to negligible percentages. It was obtained in moderately coarse lump form, being predominately 4 to 8 mesh. These lumps were further reduced by crushing and the crushed salt was graded according to particle size. Crushing was accomplished by a standard reciprocating jaw crusher with adjustable jaw clearance.

Figure 3 shows samples of a variety of crushed salt crystals, as well as a sample of spherical particles which was produced by solidification of molten droplets of salt.

MOLDING

Mold materials for making cellular aluminum castings must be permeable in order to provide an exit for the air contained in the mold, yet must be resistant to metal penetration. They must be strong up to temperatures as high as 1400 F (760 C) and inert to both salt and metal. These requirements are fulfilled to a greater or lesser degree by silicate-bonded and plaster-bonded silica molds. Other types of molding media may be modified to satisfy these requirements.

The process requires special flasks to encase the molds. These flasks must be able to withstand the high mold temperatures, and permit water cooling of the flask in order to induce the thermal gradients necessary for solidification control. Since the type of flask needed is determined by factors other than molding, these requirements are discussed in the section dealing with casting and solidification.

Molding problems encountered in cellular aluminum casting production fall within two categories —those problems associated with casting of billets and those dealing with shaped castings.

Billet Castings

Billet castings are produced in conforming steel flasks. Usually, no pattern is needed and the mold walls are protected by a refractory coating approx-

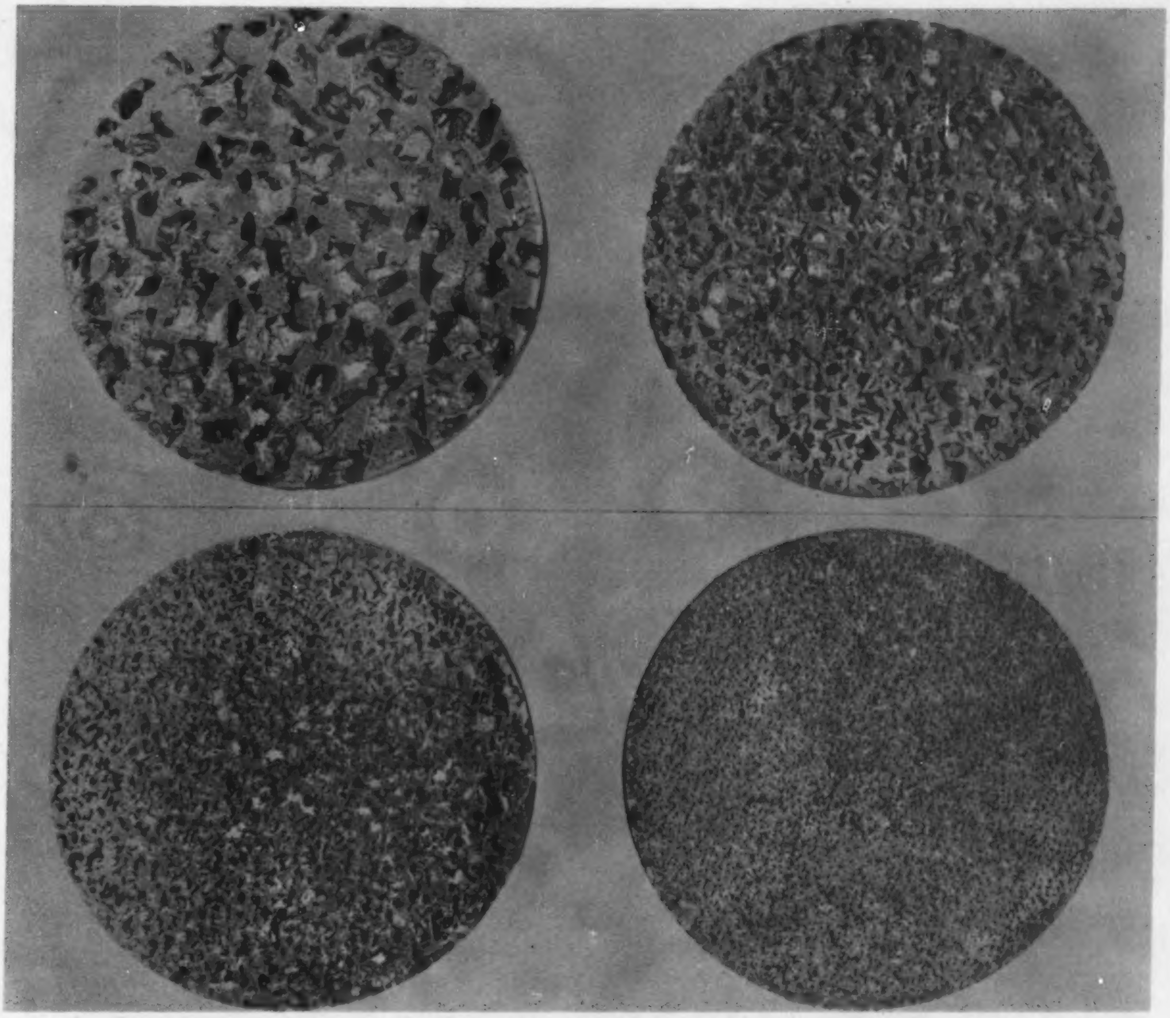


Fig. 2 — Cellular 356 aluminum alloy discs showing range of cell sizes. 2 ×. *Left to right — top* — 2.36 mm and 1.65 mm, *bottom* — 0.83 mm and 0.41 mm.

imately ¼-in. thick. A suitable material for this refractory coating is a metal casting plaster of the type used for investment molding. The coating is air dried over night, and then the mold may be filled with the graded salt crystals. The filling operation is facilitated by the use of vibration, which decreases the percentage of voids in the aggregate.

Space must be provided at the top of the mold for the feed metal necessary to compensate for solidification shrinkage. The feed metal requirements are discussed in greater detail in the section dealing with casting and solidification.

The billet flasks may also be lined with asbestos paper or with silicate-bonded sand rammed against a pattern. The rammed mold is less satisfactory than either the plaster wash or the asbestos paper lining. This is due to the greater thickness of the rammed lining, which reduces the rate of heat transfer through the flask wall.

Shaped Castings

Either plaster-bonded or silicate-bonded molds are satisfactory for shaped castings. Here again it is desirable to use flasks of approximately conforming shape in order to control solidification. The casting technique for infiltration of the salt granules is so drastic that it is difficult to perfectly seal a parting line against leakage. For this reason molds are prepared without flasks and are then bedded down in a one piece flask. Silicate-bonded sand is used for this purpose.

A number of shaped castings were made in silicate-bonded sand molds. In order to reduce the tendency for metal penetration, a special facing sand was prepared.

Material	Weight, %
Silica sand (140 mesh)	75
Silica flour	20
Silicate binder	5

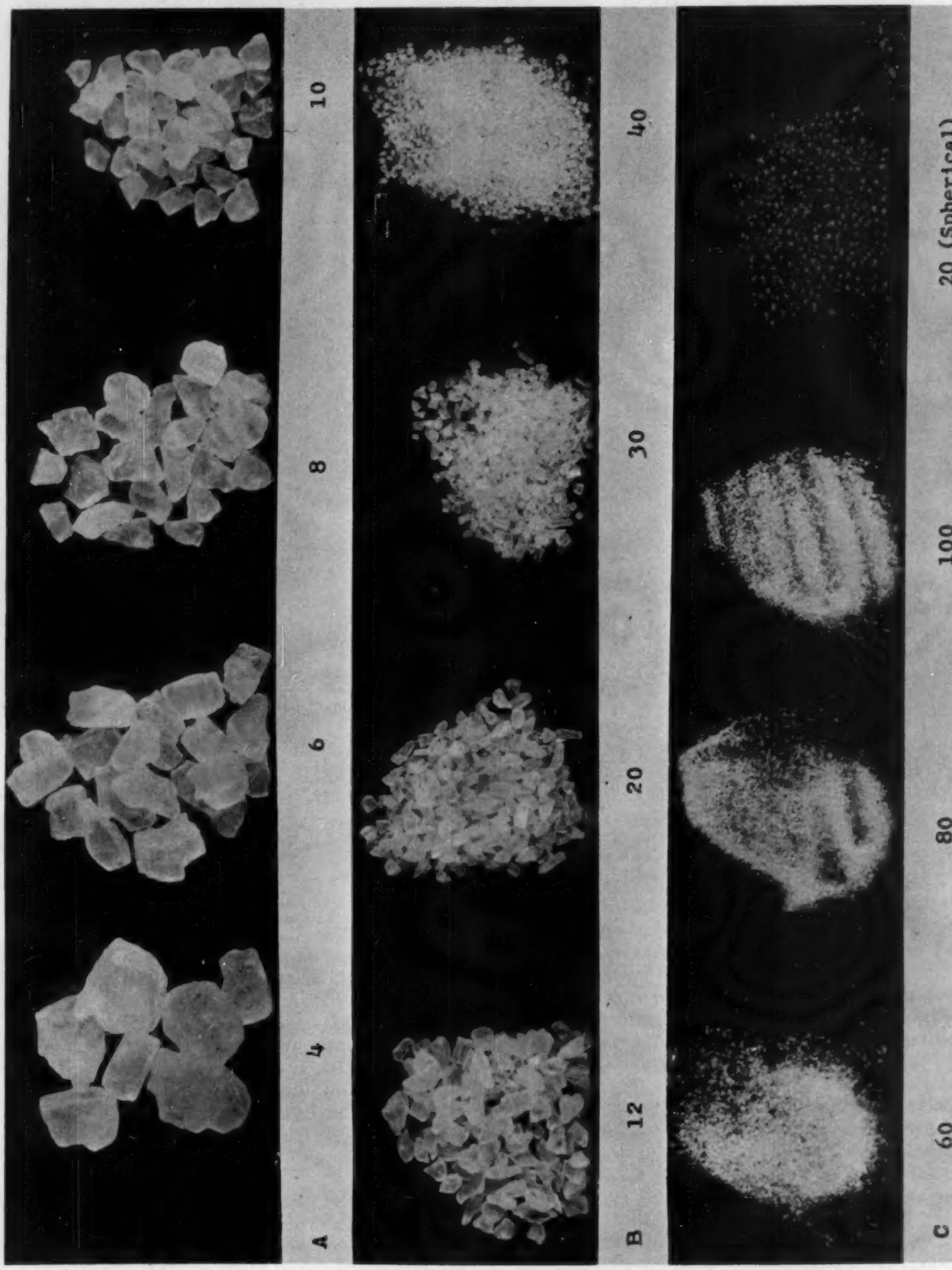


Fig. 3 — Salt particle mesh sizes. 2 X.

The backup was a silicate-bonded sand of approximately 80 AFS fineness. Before filling and closing, the mold surface may be sprayed with silicate binder as further insurance against metal penetration.

CASTING AND SOLIDIFICATION

In order to infiltrate a salt aggregate, the molten metal must follow a tortuous path between the salt granules. It must overcome the surface tension of the liquid metal and the friction of the channels through which it flows. It must force the air contained in these channels through the mold walls, which are of limited permeability.

Another factor that must be considered is that even though the product of this process is a cellular metal skeleton, it is essential that the fundamental principles common to all solidification processes be observed. Unfed solidification shrinkage results in spongy cell walls, which impair the quality of the cellular material in the same way that spongy metal impairs the quality of a conventional casting.

To pour a cellular casting successfully, three basic requirements must be fulfilled. While all of these are inter-related, they are discussed separately.

Mechanical Factors

Certain elements of the process are mechanical, since they pertain to forcing the liquid metal to infiltrate the granular compact. These elements determine the kind of equipment and methods necessary to produce successful infiltration. It was found that molds could be successfully infiltrated by gravity pouring vibration and pressure pouring. Gravity pouring can be used with coarse grades. However, more drastic methods are required to infiltrate with progressively finer granules.

Gravity pouring has been found satisfactory for pouring large billets of coarse cell structure. A tall sprue is necessary to provide the metallostatic head to develop the pressure needed to overcome surface tension and frictional effects. With sufficient metallostatic head to initiate entry of the metal into the compact, the lengthening head caused by infiltration into the compact keeps the process in operation until infiltration is complete. This method is limited to mesh sizes of No. 6 and coarser.

Vibration is useful in extending the size range of cell structures that can be infiltrated without recourse to pressure techniques. Its mechanism is apparently related to the cyclic pressures which overcome the surface tension of the liquid metal, permitting it to enter the narrow channels between the salt crystals. The method extends the range of granule sizes that can be infiltrated down to approximately No. 12 mesh. Figure 4 shows a mold clamped to a vibrator. It is essential that the mold be firmly fixed to the vibrator in order that the energy be effectively transmitted to the mold.

Pressure pouring permits infiltration of extremely fine aggregates. Castings have been made with granules as fine as 100 mesh. However, with smaller granule sizes, the possibility for entrapment of air becomes greater. An effective technique is to employ suction at the base of the mold simultaneously with the application of pressure. The suction removes the air contained in the mold. It also increases the effective pressure on the metal by the increment to which it increases the pressure differential between mold surface and metal head surface. Figure 5 is a schematic illustration of a suction-pressure apparatus used for much of this work.

Fig. 4 — Vibration casting fixture with mold fixed in position.

A clamp was used to secure the mold directly to the vacuum box. The asbestos gaskets shown are for the purpose of preventing air leaks. Perforations on the top of the box provide a passageway through which air is exhausted from the mold, the refractory bottom of the mold being permeable to gasses but not to liquid metal. Air pressure on the head was controlled by a pressure regulator. It should be noted that the volume of metal in the sprue must be enough to fill the voids within the aggregate and, also, to provide a reservoir for solidification shrinkage.

Thermal Factors

In order for the metal to infiltrate completely the salt compact, the duration of its fluid life (time during which the metal remains liquid) must be adequate. The fluid life is a function of the amount of superheat put into the metal and the rate of heat transfer to the mold walls and salt granules. Since the aggregate surface area of the granules is large, and since they occupy a volume of approximately twice that of the metal, it is apparent that the loss of heat from metal to salt must be kept low to fill the mold with metal.

This can be done by narrowing the temperature differential between the mold and the metal. Experience shows that it is necessary to preheat the mold close to the melting range of the alloy in order to avoid excessive amounts of superheat to

sustain the fluid life of the molten metal. If infiltration were the only consideration, the required mold temperature would encompass a fairly narrow band and be inversely related to the mesh of the granular compact. However, controlled solidification of the metal introduces other requirements for mold temperature.

Solidification Factors

In conventional foundry molds, solidification is controlled by means of thermal gradients developed in the solidifying casting. This is achieved by taking advantage of casting geometry, gating, and riser placement, as well as metal and mold temperatures. Since cellular metal castings must be produced in molds which are at nearly the same temperature as the molten metal, only limited thermal gradients can be anticipated. On the basis of existing knowledge of solidification, these would be inadequate to promote feeding of the solidifying casting.

In order to produce well-fed cellular metal castings, it is necessary that the casting be poured and solidified as two separate and distinct steps in the process. To obtain sound metal it is neither necessary nor desirable that the mold temperature be kept at a minimum value consistent with successful infiltration. It is important that, immediately after casting, the metal and mold be at a temperature higher than the melting range of the alloy. Thermal gradients may now be produced in the casting by cooling the lower end of the mold or flask surface.

To insure feeding of the casting, the mold and metal temperature just after pouring must be high enough so that an adequate thermal gradient can be established between the chilled area at the bottom of the mold and the feed metal at the top. The exact temperatures selected are dependent upon the length and volume of the casting to be solidified. Naturally, it is desirable to avoid temperatures in excess of those required to generate the necessary thermal gradients. Experience has indicated that it is necessary to develop thermal gradients of not less than 5 F/in.

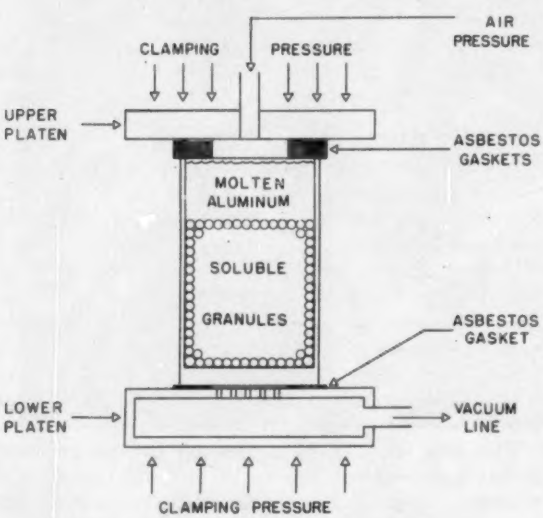


Fig. 5 — Suction-pressure casting apparatus.

Water Cooled Mold

Ideally, the mold should be cooled by means of water circulating through a water jacket at the base of the mold. It has been found, however, that adequate progressive solidification can be obtained either by use of an open trough to contain the water or by spraying water against the mold surfaces. It is not necessary to circulate the water in the trough, since water temperature may be regarded as a negligible factor compared to the heat sink provided by the water boiling in the trough. This type of cooling should be applied over the lower 25 to 50 per cent of the surface.

It is necessary, however, to avoid wetting the refractory in the mold. This is done by either using a flask which is sealed at the bottom or designing the water trough in such a way that spillage due to the boiling is kept to a minimum.

Figure 6 is a cross-sectional drawing showing the design of a flask having a cooling trough incorporated in it. A false bottom is provided in order to permit the use of suction as an aid to infiltration. The bottom is supported either by refractory brick or a bed of coarse sand. For nonferrous metals, the bottom plate may be a wire mesh reinforced plaster disc which rests on the support. If a shaped casting is being made, the mold containing the soluble granules is placed in the flask and bedded down with sand. If a billet is being made, the granular aggregate is simply poured into the flask which has previously been lined with a suitable refractory.

After the mold has been heated to the proper temperature for casting it is withdrawn from the furnace, the suction pipe is connected to a vacuum line and the metal is poured into the mold. For fine mesh sizes it may be necessary to employ a small positive pressure, as shown in Figure 5. In any event, the top of the mold should be covered with a transite sheet or asbestos paper to reduce the heat loss from the surface and guard against splashing of water into the molten metal.

Sufficient water is now poured into the trough to start the solidification process. The exact level required is based upon previous experience with the same casting. The water begins to boil almost immediately, and it is the heat of vaporization that produces the heat sink necessary to absorb the large amount of heat contained in the mold. Water is added from time to time to make up for evaporation losses.

LEACHING

The removal of salt from the aluminum-salt composite is accomplished by leaching with water. This process may be regarded as consisting of two steps:

1) the solution of all the salt in the cells.
2) the rinsing or removal of all the brine formed by solution of the salt.

It is futile to do the rinsing unless the solution process is complete.

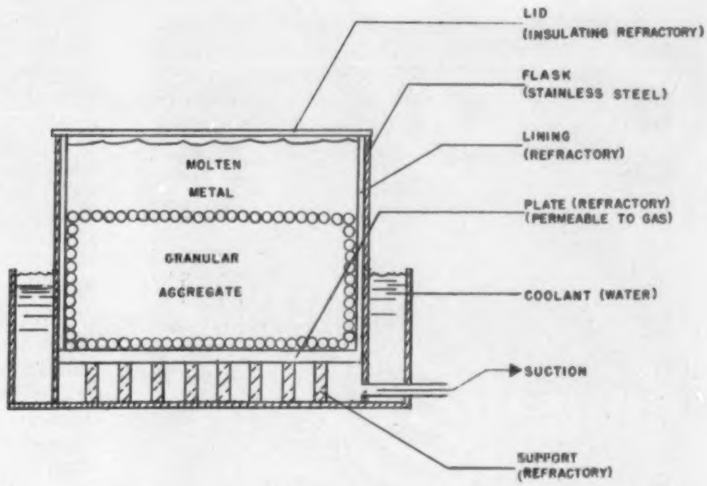


Fig. 6 — Mold with water cooling trough for solidifying cellular metal castings.

Solution Process

The leaching process as applied to these composites proceeds for the most part as a diffusion process. The leaching liquor in contact with the salt rapidly approaches saturation and the salt ions diffuse back toward the liquor of lower concentration. Due to the nature of the metallic structure, agitation of the liquid results in little benefit because of the confining nature of the cells. The rate at which salt goes into solution is affected by the area of contact and the length and geometry of the path through which the ions must diffuse.

Figure 7a is a model of a string of horizontal cells. The first cell in the string (C_1) is rapidly freed of salt because of its proximity to the dilute leaching liquor. Before the salt in C_2 can be removed, the salt in the passage between C_1 and C_2 must be leached and the ions must diffuse through this passage and out into the main body of liquor. As the solution process proceeds, the liquid column for diffusion becomes longer and longer, with more and more restricted passages to retard the diffusion process.

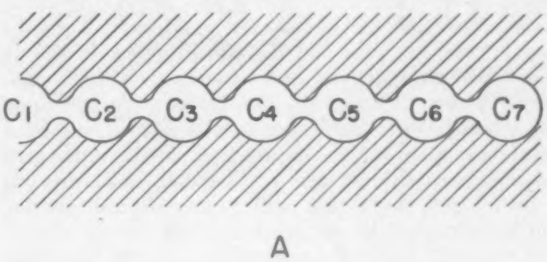
In addition to the diffusion process, the denser liquid at the exit end of the passage gravitates to the bottom of the leaching tank, which tends to maintain a lower concentration solution near the specimen. Figure 7b shows concentration gradients which develop in the tank during the leaching process.

Where the cell structure is coarse or the specimen is thin, leaching can be accomplished rapidly because the number of restricted passages to the surface are fewer. In addition, the currents set up by the movement of dense liquid toward the bottom act not only on the surface of the specimen, but through it. Where the cell structure is fine, the chief mechanism for solution of the crystals contained in the metal cell is the diffusion process previously described.

Peripheral Leaching

Figure 8 shows a section of a partially leached specimen, showing the peripheral mode of leaching. This specimen was suspended in the tank so that the right side was closest to the surface. This is the location which benefits least from the concentration currents in the tank and, as a result, shows the shallowest depth of salt removal.

If the liquid used for leaching contains some gas, either in solution or in dispersion, some of this gas may collect in the cells and form an air lock which will arrest the diffusion process. Consequently, the leaching through the blocked channel is



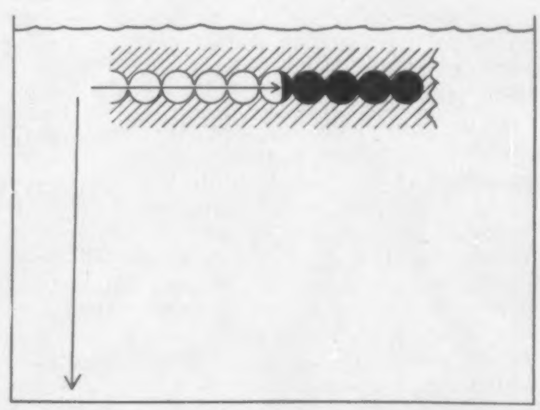


Fig. 7 — *A* — A series of cells in cellular metal. *B* — Concentration gradients developed in the tank during leaching of cellular metal.

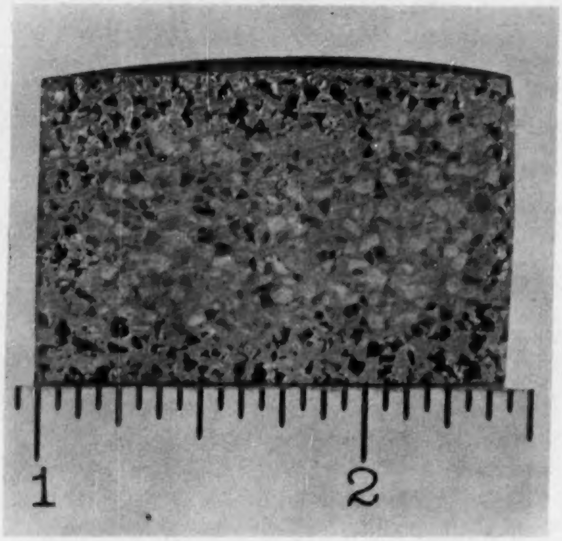


Fig. 8 — Cross-section of partially leached cellular 356 aluminum alloy.

halted. For this reason, the water used for leaching should be conditioned either by standing prior to use or, preferably, deaerated by vacuum technique.

Gas is sometimes formed as a product of the chemical action between the brine and the alloy being leached. This not only results in undesirable corrosion of the specimen, but it also causes the channels to become blocked by the gas lock. When this occurs the gas must be periodically removed by a vacuum outgassing of the structure. This is best done while the specimen is submerged in the tank. If a partially leached specimen is withdrawn from the tank, some of the liquid contained in the cells will drain away. When it is resubmerged, any air not replaced by liquid will block further leaching in the channels where this occurs.

Brine Corrosive Attack

If the corrosive attack by the brine on the specimen is severe, it is necessary to provide some protection for the metal either by adding a suitable corrosion inhibitor or by providing electrolytic cathodic protection.

On the basis of the foregoing discussion, it is evident that the specimen should be suspended near the surface of the tank in order that the currents caused by the flow of the dense liquor toward the bottom of the tank can be used to maximum advantage. Agitation of the liquor in the tank would disturb the natural favorable currents and, therefore, impede the leaching process. If a tank having a volume of ten times the specimen volume were used, the salt concentration would reach one third of saturation for that temperature if the salt concentration were regarded as uniform through the tank and no additional liquid were added or withdrawn. Actually, the liquid in contact with the specimen would contain considerably less salt than equilibrium conditions would indicate.

If the liquid is slowly drawn from the bottom during the leaching operation and replaced with clear water at the top, only three changes would insure that the brine concentration at the specimen surface would never exceed one or 2 per cent. This is 3 to 5 per cent of saturation. Reducing this salt concentration further would only have a negligible effect on the rate of leaching. This is because the concentration gradient would not be significantly affected.

Rinsing

After all the salt in the composite has gone into solution, the specimen is ready for rinsing. This should be done under a heavy flow of water, preferably through the material. After rinsing, a small amount of drippings from the specimen should be collected and checked for chloride ion. If the concentration of chloride ion in the drippings is no greater than that of the rinse water, the material has been properly leached and rinsed.

If the chloride ion concentration remains high after two or three attempts at rinsing the leaching process is not complete, and the material should be returned to the tank for further leaching. Any air entrapped in the structure must be removed after the material is submerged. By this technique, a leaching cycle is established for each material being produced. Additional pieces can be successfully leached by adhering to the established cycle.

All of the castings produced in connection with this investigation were successfully leached by the methods already described. Certain obvious improvements in leaching technique, however, were not investigated because they had no bearing on the main purpose of this study. One of these potential improvements is the use of high frequency, low amplitude vibration, such as is commonly used in electrolytic cleaning processes. This would serve the dual purpose of accelerating the rate of diffusion of the solute in the liquor of high salt concentration toward the surface of the specimen, and dislodging gas bubbles in the cell cavities which tend to block off certain cavities from action by the solvent.

CELLULAR METALS OTHER THAN ALUMINUM

The methods described can be used with appropriate modifications to produce cellular metals other than aluminum. For metals and alloys having melting points below that of the sodium chloride, the procedures followed are substantially identical to that described for aluminum except that mold temperatures and casting temperatures are appropriately adjusted. The table presents the mold and casting temperatures used to produce cellular structures in some metals other than aluminum.

Metal	Melting Point, F	Temperature, F	
		Mold	Casting
Pb	621	665	750
Sn	459	500	600
Zn	787	840	920

Certain metals, however, while falling within the melting range given above, must be treated differently because of inherent difference in their characteristics. A case in point is that of magnesium and its alloys. Because of their reactive nature it was found that these metals must be cast in molds which have been properly inhibited. One satisfactory mold medium tested was plaster bonded silica similar to that used for investment casting except that one per cent boric acid was added to the mix as an inhibitor. The castings were produced in a suction-pressure apparatus, as previously described.

Just before the metal was poured, a small amount of sulfur was dusted over the salt compact. This produced an SO_2 atmosphere in the mold, and completely inhibited burning when the metal was poured through it. Pressure to produce infiltration was applied, using argon gas at 10 to 20 psi. The largest casting produced by this technique was a 3 in. diameter billet. For this small casting it was possible to generate thermal gradients in the solidifying casting by cooling the lower extremity of the mold by the application of damp rags to the flask surface. For larger castings it would be necessary to have a water jacketed flask, since an open water spray for cooling would be too much of a hazard.

Leaching of the magnesium salt composite proved to be considerably more difficult than leaching aluminum. This was apparently due to the reaction of magnesium to water, which was accelerated by the presence of chloride ion.

It was possible to leach thin slices of this material without excessively attacking the magnesium. This was done under a heavy flow of water which decreased the chloride ion concentration. It was apparent, however, that it would be necessary to find satisfactory corrosion inhibitors or, perhaps, means for providing cathodic protection of the metal if heavy sections were to be satisfactorily leached.

Several cellular ferrous castings were also produced. One of these was an austenitic stainless steel of the 18-8 type. This was cast in a silicate-bonded mold with calcined limestone (CaO) chips as the soluble aggregate. Since no attempt was made in this limited experiment to bond the chips, it was necessary to fit a ceramic strainer core over the filled cavity in order to keep the aggregate in place during the casting operation. The mold was heated to 1800 F (982 C), and maintained at temperature for a sufficient period for the limestone to become completely calcined. The molten alloy was then infiltrated by the gravity technique.

Leaching was accomplished with a dilute nitric acid solution. This part of the process was rather slow, but the test did demonstrate the feasibility of producing cellular metal of a ferrous composition. It is planned to investigate this area in greater detail during the second phase of this program.

COMPOSITE STRUCTURES

Secondary Infiltration

The nature of cellular metal suggests the possibility of producing composite structures which may have unique and interesting properties. These structures would be a marked departure from the type currently being used and developed. The cellular skeleton represents a continuous phase of one material. The volume represented by the interconnecting cells can be filled with another material which will also be present in the composite as an independently continuous phase. A composite cast structure of this type may subsequently be subjected to working operations which, under certain conditions, will produce bonding between the two phases.

The cellular metal development promises the possibility of developing a new family of materials, which are composed of two independent but continuous matrices with a variety of properties resulting from the characteristics of the combination. While this possibility was immediately apparent when the cellular structures were first conceived, it was decided to defer development of this phase until the initial process development represented by this report had been completed.

Several composite structures, however, were prepared in order to demonstrate the feasibility of the idea. Double matrix composite materials are produced by infiltration of a cellular metal skeleton of a second material. The composites produced by this technique are — aluminum-lead, aluminum-tin, aluminum plastic and aluminum-aluminum alloy (No. 43).

These composites are representative of the many combinations that are possible. A more complete study of this aspect was deferred to the second phase of this project.

Nonsoluble Aggregates

Composite structures containing nonsoluble aggregates are produced by substantially the same process as is used with soluble aggregates. Where the aggregate material will not form a coherent briquette prior to infiltration, it is necessary to provide some means to prevent the particles from moving during casting. This is conveniently done either by capping with a coarse salt aggregate, where conditions permit, or by the use of a coarse silicate-bonded sand. The mesh size of the aggregate in all cases corresponded to the range of sizes possible with the soluble aggregates. These composites were prepared — aluminum-graphite, aluminum-silica, aluminum-boron carbide and a combination of aluminum and a proprietary ceramic material in the form of hollow spheres which have a bulk density of 0.3 to 0.4 gm/cc.

The aluminum-boron carbide composite was clad by casting a layer of pure aluminum and rolling out into strip. This corresponded to a properitary material. The working operation was successfully accomplished. The boron carbide content of this strip was approximately twice that of the proprietary material. This particular composite is being studied under another program. The other composites were prepared as illustrative of this material concept. The aluminum-graphite may be useful as a high temperature, dry bearing material. The aluminum-silica composite may be used as a lightweight abrasion resistant material. The combination of aluminum and the proprietary material may be used as a high-strength-to-weight ratio material.

Cellular aluminum can be most conveniently machined if the machining operation is performed prior to leaching. It was found generally that slower machining speeds, but comparatively heavy feeds, are most satisfactory. The abrasive nature of the salt tends to dull the cutting tool rapidly and, for this reason, carbide tools were used whenever possible. Leached material could be successfully machined without excessive smearing or fracturing of the cell walls if the cell size is smaller than 20 mesh.

TEST PROCEDURES AND RESULTS

Infiltration Efficiency

It is interesting to determine what efficiency is actually attained in the infiltration operation. In this respect, efficiency is regarded as the ratio of the weight of metal actually infiltrated to the theoretical weight possible to infiltrate. When this ratio is less than unity, either the interstices between the salt grains are not completely filled during the process of casting or, after casting, voids develop in the metallic phase due to such factors as gas precipitation or unfed volumetric shrinkage. The measure of efficiency of infiltration, therefore, is one measure of the quality of the material.

The efficiency of infiltration can be easily ascertained in a simple geometry sample, such as a cylinder. By measuring its diameter and height, the total volume V_c can be determined. The weight of the composite W_c can also be determined. After leaching, the weight can be redetermined, giving W_a the weight of the aluminum. The difference between these two weighings is the actual weight of salt in the sample composite. From the known density of the aluminum D_a and the known density of the salt D_s it is possible to calculate the theoretical weight of aluminum needed to fill completely the interstitial spaces between the salt particles.

This computation is only correct if each salt crystal, which completely fills its cavity at the casting temperature, still completely fills its metal cavity at room temperature. However, this is not valid since a significant difference does exist in the coefficients of thermal expansion of the aluminum and the salt. In cooling the aluminum alloy from its solidification point to room temperature the volumetric contraction is approximately half that of the salt crystals.

This means that after the composite has cooled to room temperature the salt crystals are smaller than the cavities in which they lie. It is therefore necessary to correct for the void volume resulting from the greater contraction of the salt. The exact volume of voids created by this contraction is difficult to determine, due to the fact that the data relating to the contraction coefficient over the entire temperature range are not readily available. It does appear, however, that this factor would be approximately 5 per cent. In order to bring the calculated absolute values of efficiency of infiltration into closer relationship with reality, it was decided to multiply the expression $(W_c - W_a)$, which represents the actual weight of the salt component, by a constant K. The value of this constant for the aluminum alloy-NaCl composite is 1.05. The theoretical weight of aluminum W_a^t can be expressed as:

$$W_a^t = \frac{D_a}{D_s}\left[\, V_c D_s - K\,(W_c - W_a)\,\right]$$

The per cent efficiency of infiltration, EI, is:

$$EI = \frac{W_a}{W_a^t} \times 100$$

This equation was used to calculate the *EI* of the specimens used for the compression tests.

As work on this project progressed, as might be expected, a gradual improvement in processing techniques occurred with consequent improvement in the quality of the cellular metal produced. It is important to demonstrate the current level of development with respect to quality.

The most significant parameter which can be related to quality is efficiency of infiltration. As a demonstration of the current quality level, four cellular castings (1⅝-in. in diameter by 6 in. long) were prepared. The cell sizes corresponded to mesh sizes of 6, 10, 20 and 40. In order to emphasize the severity of this test, these castings were made with high purity aluminum rather than the 356 alloy which had been used for most of the prior work. The pure metal substantially increased the problem of overcoming solidification shrinkage. Three one in. high cylinders were removed from designated locations along the length of each casting. These cylinders were machined to 1½-in. diameter, carefully measured and leached, and the efficiency of infiltration and apparent density were calculated. The results of these tests are shown in Fig. 9.

These data show a significant improvement in the efficiency of infiltration of all the cell sizes. All nine samples representing the 6, 10 and 20 cell sizes showed a constant *EI* of more than 98 per cent along the full length of casting tested. The slightly lower *EI* values obtained for the 40 cell size material are probably due to the larger number of interstices between adjacent grains that have to be filled. Incomplete filling is probably responsible for deviations from the desired 100 per cent *EI*.

The apparent density values are relatively constant over the length of each specimen. The variation in apparent density among specimens is due to differences existing in the particle size distributions of the sieve fractions used. Even though a single sieve fraction was taken for each cell size, certain variations in relative particle size distribution would be expected.

COMPRESSIVE STRENGTH

The mechanical properties of cellular aluminum have yet to be completely defined. Because of its simplicity and the relationship that it bears to the structural loading anticipated for the material, compressive strength was selected as the principal parameter for study. Specimens for test were machined to 1.500 in. diameter cylinders 1.000 in. high. They represented cell dimensions corresponding to granule sizes of 4 to 60 mesh with both angular and spherical shapes.

The 356 alloy (7 per cent Si - 0.3 per cent Mg) was selected as a representative aluminum alloy and

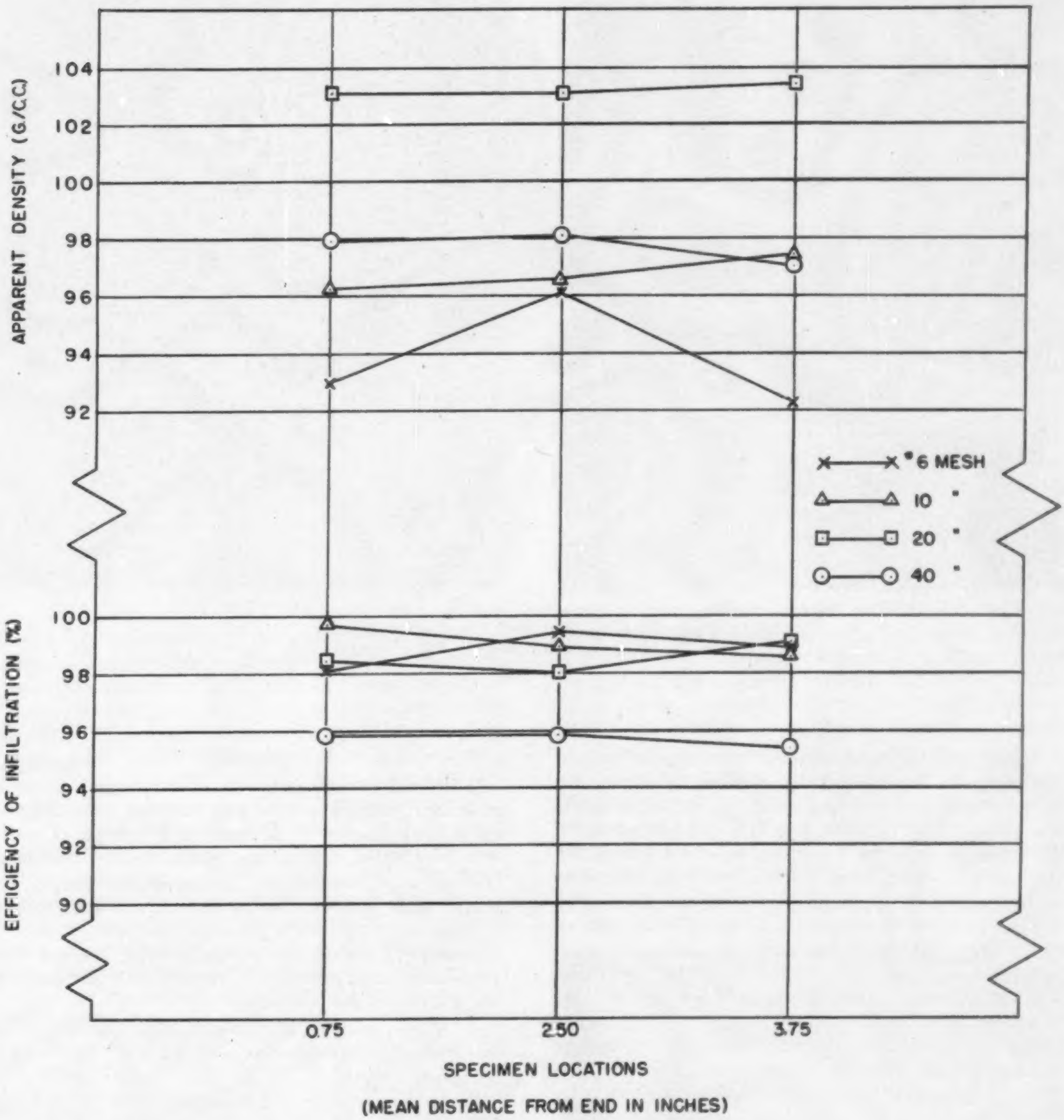


Fig. 9 — Apparent density and efficiency of infiltration of high purity aluminum cellular castings.

the specimens were tested in both the as-cast and heat treated condition. The compressive index figure was the one commonly used for materials of this type, which is the stress level recorded at 10 per cent compression. In addition, the stress level at 0.2 per cent offset was also recorded. One series of specimens was tested as metal-salt composites and a few metal-plastic and metal-ceramic specimens were also included.

The table gives a few representative values obtained by compression testing cellular and composite samples:

Material	Cell Size, mesh	Yield Strength, psi, 0.2% offset	Compressive St., psi, 10% def.	Apparent Density, g/cc	Efficiency of Infiltration, %
Cellular Materials					
356 As Cast	10	1870	3020	1.018	93.7
356 As Cast	30	2130	3700	1.102	92.5
356 T-6	10	2780	4300	1.009	91.3
356 T-6	30	2510	4390	1.067	90.6
Composite Materials					
356 + Epoxy Resin	60	8300	—	1.687	
356 + Propietary Material	60	17,300	—	1.643	
356 + Salt	20	10,650	—	2.30	

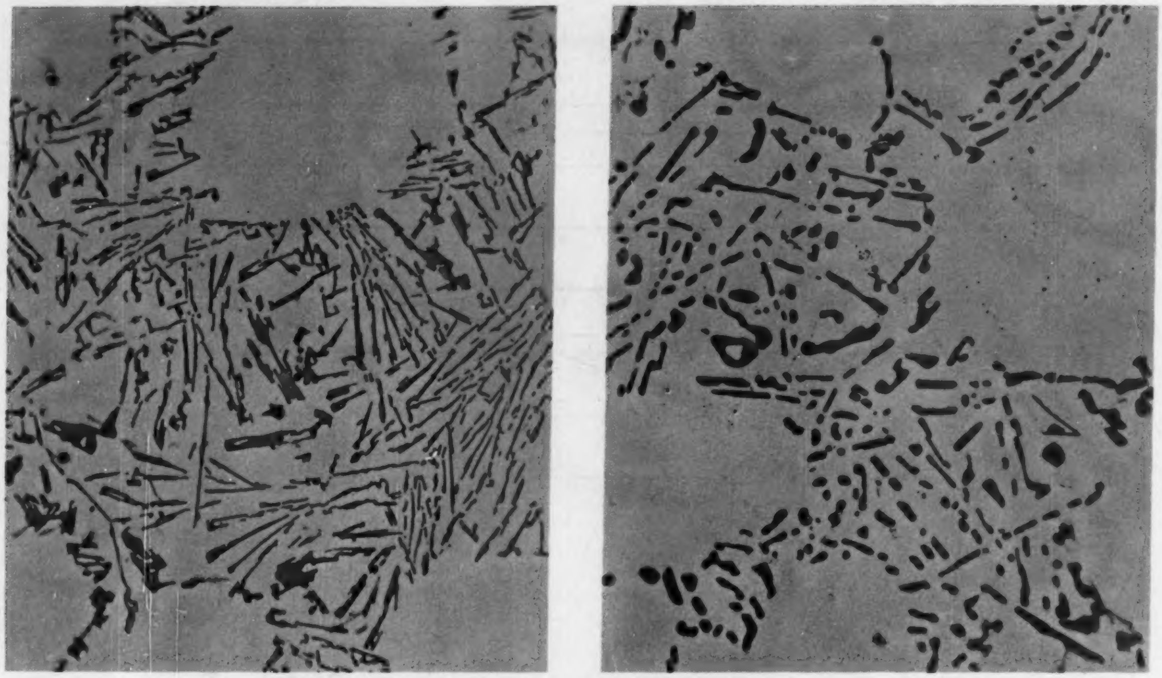


Fig. 10 — Microstructure of cellular 356 aluminum alloy no. 10 (1.65 mm) cell. 250 X. *Left* — as-cast structure. *Right* — T-6 structure.

These data are illustrative of the range of properties that can be expected from these materials. An examination of all the data indicates that the strengths are independent of mesh size. The variations which were found could be attributed to characteristics of the sample which were related either to efficiency of infiltration or apparent density values. The use of a filler to provide support for the cell walls during compressive loading substantially increases the load-carrying capacity of the material. The aluminum alloy-proprietary composite is a particularly interesting example of this kind of structure. Though the density of the material is only about 60 per cent of solid aluminum alloy its compressive yield strength approaches that of the solid alloy in the as-cast condition.

MICROSTRUCTURE

Metallographic samples were prepared from cellular 356 alloy of an intermediate cell size (10). One of the samples represented the as-cast condition and the other the solution treated and aged condition (T-6). These structures are shown in Fig. 10. The silicon constituent is present as a coarse phase in both conditions. Prior to heat treatment, the lamellar silicon structure is typical of alloys of this type.

After heat treatment (which consisted of solution treating at 1000 F (538 C) for 16 hr, quenching, and aging at 310 F (154 C) for 4 hr, the silicon particles became rounded. A few finely dispersed voids evident in the structures are probably due to unfed solidification shrinkage.

DENSITY

The final density obtained in a cellular casting is intimately related to the classic problem of packing of particulate matter. This problem is treated in great detail by Parisi, Nutter and Michalowski.[2] It is most conveniently handled by assuming the particulate matter to be spheres. On the basis of this assumption, a container filled with uniform size spheres of any diameter packed in the closest possible manner and neglecting edge effects will occupy 74.0 per cent of the volume of the container.

It is also possible to accommodate one sphere of size 0.414 D, and two spheres of size 0.225 D, for each principal sphere of size D. The smaller spheres fit in the space between the adjoining principal spheres. Ideally, it is possible to pack an additional 7.1 per cent of the 0.414 D spheres and 5.3 per cent of 0.225 D spheres into the same cavity. These percentages are based on the volume of the principal sphere fraction. It is therefore theoretically possible to fill the mold to 83.17 per cent capacity, using the appropriate percentages of these three size ratios.

This would indicate that it is possible under these conditions to produce a cellular metal having a void volume of approximately 83 per cent, and, conversely, an apparent density of approximately 17 per cent of the true metal density.

Since ideal particle shapes, size distributions and packing efficiency cannot be attained in practice, the apparent densities obtained are substantially higher than those indicated from theoretical considerations.

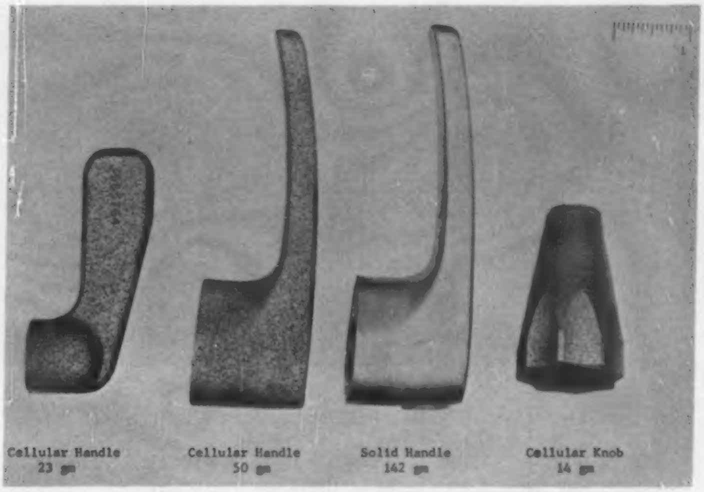


Fig. 11 — Cellular aluminum alloy castings.

In addition, since this was the initial phase of the project, it was believed that it would be desirable to limit this work to cellular structures having a single size distribution.

CASTINGS

One of the advantages of the cellular metal technique is the capability of producing shaped castings to closely controlled tolerances. As a demonstration of this characteristic of the process, several investment molds were prepared from existing patterns. These molds were invested and dewaxed by standard techniques and then filled with 40 mesh salt crystals. The molds were then heated to the casting temperature for 356 alloy, infiltrated and cooled in the manner already described. Figure 11 shows three such castings.

For comparison purposes, one solid investment casting is also shown. It is evident that, aside from the inherent porosity of the material, the surfaces and detail are equivalent to those of conventional castings. One of the characteristics of the as-cast surface is that, in comparison with the cell dimensions, only small pinholes appear at the surface. This is due to the fact that the junction between the crystals and the mold wall, for the most part, is a point of contact. These surface holes could be further reduced in size by the use of spherical particle shapes and by an increase in the pressure used for infiltration.

Another shaped casting that was produced was the electronic mounting plate shown in Fig. 12. This casting was made in a silicate-bonded mold. Suction in combination with 60-cycle vibration was used to effect infiltration. A 12-mesh crystal was used. Since the requirements of this component were such that a solid flange was desired the pattern was molded in the flange-up position, and only that part of the mold which was intended to be cellular was filled with the crystals. Figure 13 also shows the casting in cross-section, and reveals the solid flange and the cellular structure of the body.

A number of billets approximately 10 in. in diameter by 24 in. long were cast by the techniques described for billet castings. One of these billets was required to have a solid core running through the axis of the casting. This was accomplished by positioning a metal core in the center of the mold before filling. The core was lubricated and wrapped with kraft paper prior to insertion in the mold to prevent the salt crystals from adhering to its surface. The mold was then heated sufficiently to drive off the mold moisture.

The salt solution on the crystals, which was formed by the condensation of the mold vapors, was evaporated during the heating cycle. The crystallization of the salt at at the point of junction of the salt crystals made the salt component a coherent mass. The metal core was then withdrawn. Any of the paper wrapping not removed at this time was consumed during the later firing of the mold. The mold was then heated to the proper temperature for casting and infiltrated with molten aluminum.

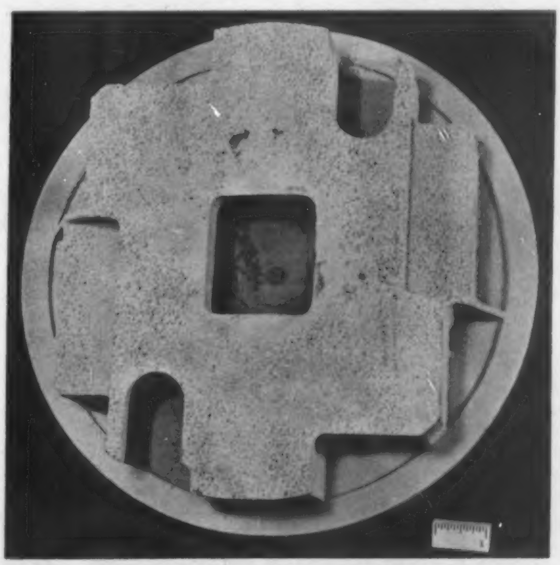


Fig. 12 — Cellular 356 aluminum alloy mounting plate casting.

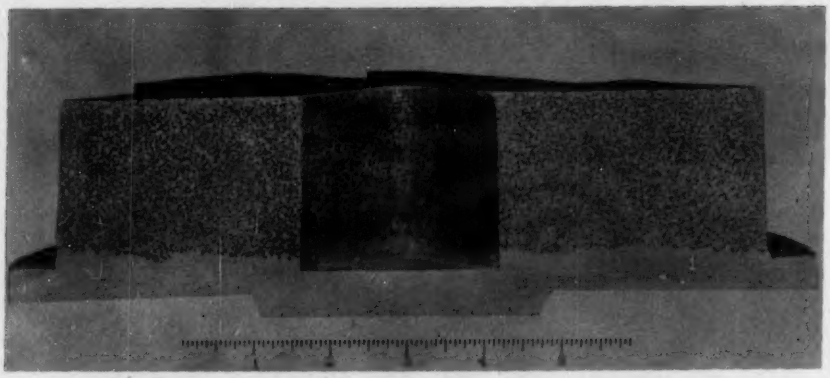


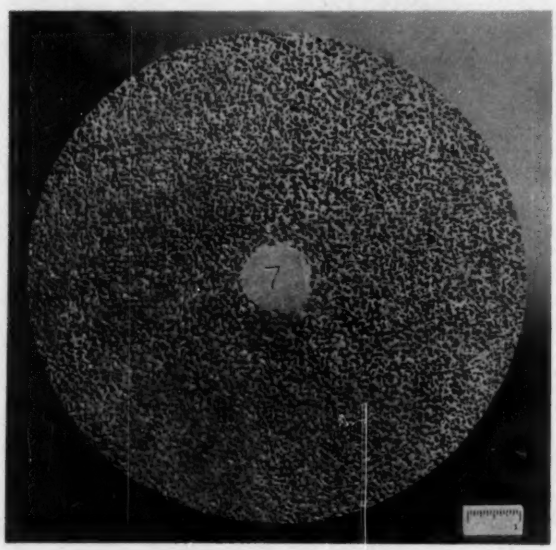
Fig. 13 — Cross-section of cellular aluminum mounting plate casting.

In this case the crystal size was 10 mesh and only vibration was used as an aid to infiltration. Figure 14 shows a transverse section taken from this casting. Similar techniques can be used to produce other combinations of solid-cellular geometry.

POSSIBLE APPLICATIONS

While the text of this report makes occasional reference to possible applications for cellular metals, it is appropriate that this report should contain a consolidated description of those applications which have either been envisaged by the authors or suggested to them. It is emphasized, however, that these suggested uses are speculative, and are indicated for the purpose of defining some of the areas where the unique properties of this material may be used to advantage.

The successful development of any single application depends, first of all, upon careful design to realize the full potential of the particular characteristics of cellular metal which are being exploited for the application. In addition, the material itself, which can be produced with an infinite variety of characteristics, must be tailored for the specific application.



Metallic Filters

The large void volume promises the possibility of filter elements which would have substantially greater particle retention characteristics than powder metal filters. It would be necessary to refine techniques used for cellular metal production in order to exercise greater control of the dimensions of the intercellular channels. This would probably require the use of accurately controlled spherical soluble granules.

Exhaust Muffler Elements

Powder metallurgy components have recently come into use as diffusers for the exhaust of pneumatic tools. Applications of this type can no doubt be filled by cellular metals with equal or better facility. This suggests the possibility of use as exhaust elements for internal combustion engines. Components made of cellular material may be much more efficient than conventional baffle elements and may possibly be designed to reduce the amount of exhaust particles released to the atmosphere.

Bearing Materials

The cellular skeleton may be used as a means for providing structural support for lead and tin base bearing compositions. The characteristics of the material permit much larger percentages of the active bearing component to be incorporated in the material than is possible with either powder metallurgy or conventional alloying.

Sandwich Core Material

The nature of cellular metal is such that it is not competitive with honeycomb structures because of its substantially greater density than that typical of

Fig. 14 — Cross-section of cellular 356 aluminum billet.

honeycomb construction. It may, however, find application in structures where contoured sections must be supported by a lightweight core. This may be in such areas as leading edges of wings or fin surfaces. This can be accomplished by using cellular cores and casting the desired skin against it. The metal would be firmly keyed to the cells at the surface of the core and would benefit from the chilling that the cellular core would provide.

Such a structure would probably require neither brazing nor organic adhesive for assembly. More important than this, however, is that it may be possible to provide transportation cooling for such structures by circulation of suitable coolants through the interconnecting cells that make up the core.

Jigs and Fixtures

Cellular metal, particularly in fine mesh sizes, is capable of being easily deformed to take reasonably accurate impressions of a solid metal body of greater strength. This property suggests a possible use in the construction of machining jigs and fixtures. A stock part may be used to hob its impression in a block of specially prepared cellular material. This impression can then be mounted in the particular machine or fixture intended for the operation, and subsequent parts can be accurately positioned by means of the hobbed cavity.

The porous nature of the material may also be of benefit in permitting coolant liquid of gasses to be directed against the component while it is being machined or otherwise processed. The low density of the material may be a further significant advantage, particularly if the fixture requires manual handling.

Energy Absorption Material

One of the unique properties of cellular metal in comparison with other metallic materials is the nature of its response to compressive loads. Cellular metal can absorb energy by the mechanism of relatively easy and controlled collapse of the cell walls. This suggests that in a combination of two materials – one strong and the other weak, the weaker material may afford protection for the stronger material by its sacrificial collapse and attendant absorption of energy. This characteristic suggests applications where it is desired to absorb energy released by accidental impacts.

A cellular metal element of the proper energy absorbing capacity may be useful in preventing serious damage to a vehicle and its occupants when it is involved in an accidental collision.

Heat Transfer

The limited study of the thermal properties of cellular metal suggests a variety of applications based upon its unique thermal characteristics. In dynamic systems, the large, controlled surface area can be exploited for efficient heat exchange, particularly between a heat source and a gas flowing through the system. In passive systems, the low thermal conductivity may be used for thermal insulation, a function not normally possible with metals.

Electrochemical Processes

The combination of permeability and large surface area may be employed to advantage in electrochemical processes. This would be principally in connection with electrodes which can be prepared to provide increased surface area. These applications include plating processes, battery electrodes and anodes for galvanic corrosion protection of such structures as water tanks, pipe lines and ship hulls.

Electronic Packaging Systems

One of the most critical segments of modern missile systems is the electronic package which is a part of the fuse system. In order to obtain maximum reliability in this area, a heavy weight penalty is paid by the use of a massive, rigid chassis to support the electronic components. The chief function of this chassis is to provide electrical shielding and to protect the components from damage due to vibration generated during launching and in flight.

It is this particular application that originally stimulated the development of cellular aluminum. The cellular structure promises to reduce chassis weight by almost two-thirds while providing effective shielding and acting as an absorber for the vibrational energy generated during flight. Several prototype components have already been produced and are being tested.

The process for cellular metal manufacture may be adapted to the production of composite materials. This can be accomplished either by means of secondary infiltration of a lower melting material into the cellular skelton or by using the secondary substance as the aggregate for filling the mold. The former method is illustrated by the proposed application for bearing materials. The latter method may be used for the production of composites for radiological shielding. Some of the systems thus far suggested include lead-boron carbide and aluminum-boron carbide. By this means relatively large volumes of boron carbide can be retained in an aluminum matrix, which will not only support the active shielding material but will be of structural benefit to the system.

ACKNOWLEDGMENT

The authors wish to express their gratitude to Messrs. R. W. Warren and R. R. Palmisano of the Diamond Ordnance Fuze Laboratory, and Mr. H. Rosenthal of Pitman-Dunn Laboratories, for their interest and the many constructive suggestions offered during the course of this study.

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WELDABLE AS-CAST NICKEL ALUMINUM BRONZE COMPOSITION AND MICROSTRUCTURE

by M. L. Foster and S. Goldspiel

ABSTRACT

The potentials of Ni-Al bronze for propeller castings, which include good mechanical properties and excellent cavitation resistance, could be enhanced by a determination of compositions and structures which give consistently weldable as-cast material. This is a report of the first phase of an investigation designed for this purpose and deals with the relationship between aluminum content, mechanical properties, microstructure and weldability. The sample material included conventional keel blocks and specimens taken from a groove-welded wedge-block casting, grading in thickness from ½ to 3½-in., and simulating during welding restraints which are encountered in actual propeller repairs. The results of tests indicate that the minimum percentage of Al needed for a weldable structure is close to 9 per cent, and that the optimum as-cast structure in the thickness range considered is obtained with 9.5 per cent Al at 5, 4, and 0.5 per cent Ni, Fe and Mn, respectively, which were kept relatively constant. Pb and Si, elements considered as "detrimental," did not adversely affect weldability at levels of 0.10 and 0.18 per cent, respectively, in an otherwise optimum composition. Optimum mechanical properties obtained to date and relationships between metallographic structure, mechanical properties and weldability, are discussed.

INTRODUCTION

Of the several alloy types being considered for propeller castings, nickel-aluminum bronze is one of the more promising. Under optimum conditions, castings of this alloy type combine high strength and ductility with excellent corrosion (cavitation and erosion) resistance. To date, propellers of nickel-aluminum bronze as large as 50 tons have been cast for commercial use. Some propellers of this alloy type have been used successfully by the Navy in ships which operate under extremes in marine conditions, as represented by arctic waters.

This alloy is lighter than the high tensile brasses, and hence makes possible (a) considerable savings in fuel consumption, (b) reduced wear and tear on main propeller shafts and (c) the use of thinner sections in design, due to its higher strength-to-weight ratio. Its resistance to corrosion allows propellers to retain smooth surfaces for a longer time, thereby increasing propeller efficiency and reducing maintenance costs. The major obstacle, reported for the alloy type, is that its fabricability (particularly bending and welding properties) often present difficulties.

It is the purpose of this investigation to study compositions and structures of castings of this material which, with due allowance for mass effects, will yield consistently fabricable material, including good castability, bendability and weldability.

LITERATURE REVIEW

The search for improved propeller alloy materials for maritime as well as naval use within the past ten years has resulted in the appearance of a number of articles in the technical literature on nickel-aluminum bronze. A brief review of the literature will highlight results of previous work and indicate the manner in which the current investigation has been planned to supplement and extend it. Vanick,[1] in a comprehensive review article, considers the Ni-Al bronze casting alloy with relation to tin bronze, red brass and manganese bronze, the latter being used as a yardstick as far as properties are concerned.

In addition to nominal compositions, he presents comparative data on salt water fatigue, cavitation resistance, corrosion fatigue and corrosion in sea water under varying types of exposure. He also treats briefly the subjects of heat treatment, heat and wear resistance, fabricability including machinability, welding and brazing. The two compositions of Ni-Al bronze alloy discussed in this paper are based on earlier development work of W. C. Stewart and W. L. Williams.[2] It is noted that the elongation quoted for the two alloys considered is lower than specification requirements[10] for the currently used alloys.

As far as weldability is concerned, Vanick states that the use of standard aluminum bronze filler with metal arc or oxyacetylene produces satisfactory welds, with better ductility than can be achieved with Ni-Al bronze filler. The work does not indicate the extent to

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NOTE: The opinions or assertions contained in this paper are the private ones of the authors and are not to be construed as official or reflecting the views of the Naval Service at large.

which the nominal composition must be adhered to in order to achieve the good mechanical properties and fabricability claimed. In addition, the effects of mass on structure, properties and fabricability, while briefly mentioned, leave much to be desired for actual guidance and production. Impact properties for the alloys were not presented.

Cook, Fentiman and Davis[3] give a rather extensive discussion of the properties of wrought Ni-Al bronze as related to composition and metallographic structure, and, thus, provide considerable background for an understanding of factors which must be controlled in the development of cast alloy counterparts.

Inert Gas Metal-Arc Welding

Welding of Ni-Al bronze castings is treated in considerable detail by Cahill.[4] The author discusses welding using the inert gas metal-arc process with both Ni-Al bronze and Al bronze filler wires. He concludes that the latter is considered preferable at the time of the study, but that continued experimental work in progress on modifications of the former wire may lead to higher strength deposits. It is of interest to note that the procedure developed by Cahill had the decided advantage that little or no preheat was required compared to the preheat, of as high as 800 F, needed for the method used previously, i.e., manual metal-arc welding with Al bronze. Cahill's work is, however, limited to a uniform section thickness, and takes no account of variations in nominal composition or the effects of impurities (normally present in commercial ingot and returns) on weldability.

A discussion of all types of aluminum bronzes, from a point of view which is of interest to designers, is contained in an article by W. L. Williams.[5] Applications considered include shipboard machinery, condenser components and propellers, with emphasis on requirements for naval vessels. Comparative chemical composition, mechanical properties, corrosion, fatigue and magnetic property data are included. The author makes the important observation that "aluminum bronzes can be used for a wide variety of shipboard hardware, provided designs are consistent with properties. It is important, however, that the individual alloys be screened carefully in selecting materials for specific applications."

The current investigation at the Material Laboratory is being conducted with the latter thought in mind, because Ni-Al bronze for large propeller castings must (a) tolerate ingot and remelt with reasonable amounts of impurities to keep cost of material down, (b) be fabricable (bendable and weldable) in the as-cast condition, since heat treatments of most ship propellers are impractical, due to size and (c) be repairable, if they contain defects associated with original casting. In addition, the choice of the individual alloy should be backed by a sufficient amount of information on heat treatment to improve fabricability, if necessary, and thus obviate sizeable financial losses otherwise entailed.

Valuable information on casting practices for Ni-Al bronze as applied to the production of large propellers, is contained in a paper by A. J. Smith.[6] Factors considered in detail include melting practice, gas absorption, molding methods and materials, refractories, fluxes and pouring temperatures for both small and large castings. His treatment of large casting practices is of particular value because they are significantly different than for smaller castings. This knowledge is limited to a small number of large producers.

Comparative advantages to manganese bronze are also discussed, and include improved propeller efficiency, 18 per cent reduction in weight, low notch-sensitivity and overall economy, considering service life and lower maintenance costs. The author's statement that "aluminum bronze is readily repairable" is, however, not completely borne out by experiences reported by a number of investigators and observed in connection with a limited number of repair jobs, in which the Material Laboratory was involved. In this connection, it should be noted that this factor represents one of the prime considerations in the Laboratory's current investigation, since under certain conditions of solidification, critical amounts of alloying elements or presence of impurities may influence weldability.

PREVIOUS WORK

For purposes of completeness, a summary of some preliminary work by the Material Laboratory, which was reported to the Bureau of Ships[7] as a basis for the support of a formal investigation, is presented. This preliminary work was based on results obtained from 16 heats of nickel-aluminum bronze produced in the Shipyard foundry, since the alloy was first cast here in June 1956. The interest in the alloy at that time came about as a result of a request from the Shipyard welding engineer that the foundry cast a patch of a specified composition (Item A, Table 1 shows the actual analysis). This patch was to be used for the salvage by repair welding of an 18 ft diameter ship propeller.

Since no stock of the required ingot was available, the foundry, with technical assistance from the Material Laboratory, produced and pigged a small quantity of metal of the desired nominal analysis. Four attempts were necessary to overcome melting and casting difficulties to produce the actual patch which had the shape of a blade tip with chord length maximum width and maximum thickness of 5 ft, 2 ft and 3½-in., respectively. The final casting, produced as shown in Fig. 1, had the specified composition and mechanical properties shown in Item B, Table 1, and a soundness which satisfied rigid radiographic and surface penetrant tests. This patch was satisfactorily welded to the ship propeller under supervision of the Shipyard welding engineer.

Subsequently, in Jan. 1957, at the request of the Shipyard welding engineer, two additional heats were melted and used for casting of test plates which also welded satisfactorily. The compositions and tensile properties of these heats are shown in Table 1, items C and D.

In Feb. 1957, a second patch, similar in shape to the first one described above, was cast for the repair of another ship propeller. The analysis of the pro-

TABLE 1 — DATA FOR PRELIMINARY EXPERIMENTAL CAST NICKEL ALUMINUM BRONZE HEATS

		Chemistry								Mechanical Properties				
Item	Identification	Cu	Ni	Fe	Mn	Pb	Sn	Si	Al[a]	TS in Kips[j]	YP in Kips[j]	Elong., % in 2 In.	Hardness, Rb	Weldability
A	Initial Anal.	80.5	5.2	4.0	0.5	—	—	—	9.4	87.5	36.7	14.0	82	Satisfactory
B	15S[d]	81.0	5.4	4.0	0.6	0.03	0.01	0.1	9.0	84.5	37.5	19.5	82-85	Satisfactory
C	82X[e]	79.7	4.8	4.6	0.6	0.03	0.01	0.1	10.3	88.5	46.2	10.5	85-88	Satisfactory
D	59Y[e]	79.1	4.8	4.3	0.6	0.03	0.01	0.1	11.2	87.6	32.6	15.0	83-85	Satisfactory
E	Propeller[f,c]	80.5	5.5	5.1	0.9	0.01	0.02	0.05	8.0	—	—	—	86-92	Satisfactory
F_1	A4[g]	82.1	5.4	3.6	0.7	0.06	0.01	0.1	8.3	78.5	39.5	25.0	71-74	Cracked Badly
F_2	Patch A4[h]	—	—	—	—	—	—	—	—	78.0	23.7	23.0	76-80	Cracked Badly
G	R100 6A[b]	—	—	—	—	0.02	0.01	0.2	—	—	—	—	92-95	Satisfactory
H	R100 6C[b]	—	—	—	—	0.07	0.01	0.05	—	—	—	—	74-79	Cracked Badly
I	R100 6E[b]	—	—	—	—	0.09	0.04	0.05	—	—	—	—	74-79	Satisfactory
J	R100 6G[b]	—	—	—	—	0.13	0.01	0.05	—	—	—	—	76-82	Cracked Badly
K	R100 6H[b]	—	—	—	—	0.15	0.01	0.05	—	—	—	—	76-85	Satisfactory with peening
L	G51	80.2	5.0	4.4	0.79	0.01	0.01	0.05	9.5	83.0	38.0	19.5	78-81	Satisfactory
M	G99	79.8	5.2	4.0	0.57	0.04	—	—	10.3	80.0	37.5	15.0	85-87	Satisfactory

NOTES: a. By difference.
b. Material furnished by industrial firms.
c. Plus Mg.
d. Satisfactory patch for one ship's propeller repair.
e. Weld test plate casting.
f. Second ship's propeller proper.
g. Separately cast test bar for unsatisfactory patch intended for ship (f) propeller repair.
h. Tensile bar cut from patch casting.
j. 1000 lb/sq. in.

peller material is shown under item E, Table 1. The manufacture of this patch involved essentially the same procedure established in casting the first successful patch. The composition and mechanical properties of the separately cast test bar and the patch itself are shown in Table 1, items F_1 and F_2, respectively. The patch cracked on welding.

This behavior could not be explained by the composition and properties of the separately cast test bar which indicated a lower aluminum content, higher elongation and lower tensile strength compared to the first patch. These differences would generally be expected to result in improved weldability. A check was therefore made on the bar machined from the patch proper to determine significant differences between it and the separately cast test bar. The results showed no significant differences. Test plates from succeeding heats made with the same procedure as for the satisfactory patch also cracked on welding.

Chemical and Metallographic Tests

At this point, it was decided to check whether the difference in weldability might be associated with (a) presence of tramp elements; (b) microstructure as affected by composition, mode of solidification and rate of cooling.

A chemical check for phosphorus and sulfur on (a) the successful patch, (b) the ship propeller proper and (c) the unsuccessful patch indicated no significant differences, all results being below 0.01 per cent. A comparative spectrographic analysis for metallic impurities of the several heats made indicated that the ship propeller contained magnesium, and that the patch which cracked had higher lead than the other samples. The results are shown in Table 1, under items B, C, D, E and F_2.

The metallographic structures for the several samples discussed and presented in Fig. 2 show major differences. The structures can be grouped into three significantly different types. Figure 2a shows the microstructure representative of the three foundry heats

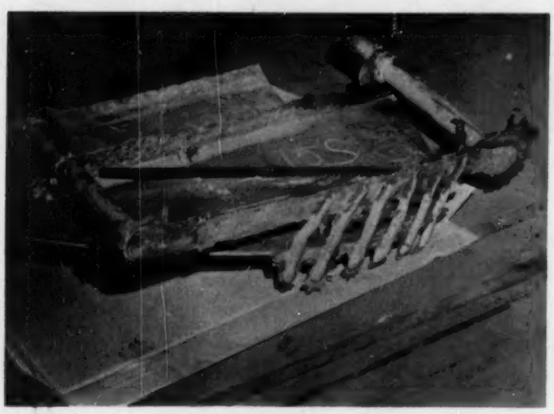


Fig. 1 — Satisfaction patch casting produced for repair of one ship's propeller. *Top* — riser end view. *Bottom* — gate end view.

which welded without trouble. It will be noted that it contains essentially two phases, one of which is in the form of elongated grains. Figure 2b represents the microstructure of the ship propeller casting. It is also a two phase structure, but differs from the former in that the grains are more equiaxed.

It is to be noted that the propeller material also differs from the foundry castings in that it contains Mg which was probably used to aid deoxidation. No deoxidant additions were used in the Shipyard castings, since it was considered that the relatively high aluminum content of the alloy type would provide the necessary deoxidation under conditions of melting used. The propeller casting welded satisfactorily. Figure 2c represents the structure of the heat from which the unsatisfactory patch, intended for the repair of the ship propeller, was cast. At 120 × the structure appears to be essentially single-phased and equiaxed.

However, the presence of a second phase at grain boundaries is indicated by Fig. 3a, which represents the structure of this material at a magnification of 500 ×. This material consistently cracked on welding. Figure 3b represents the microstructure in the heat affected zone after welding; the fact that the cracking is intergranular in nature appears to be significant.

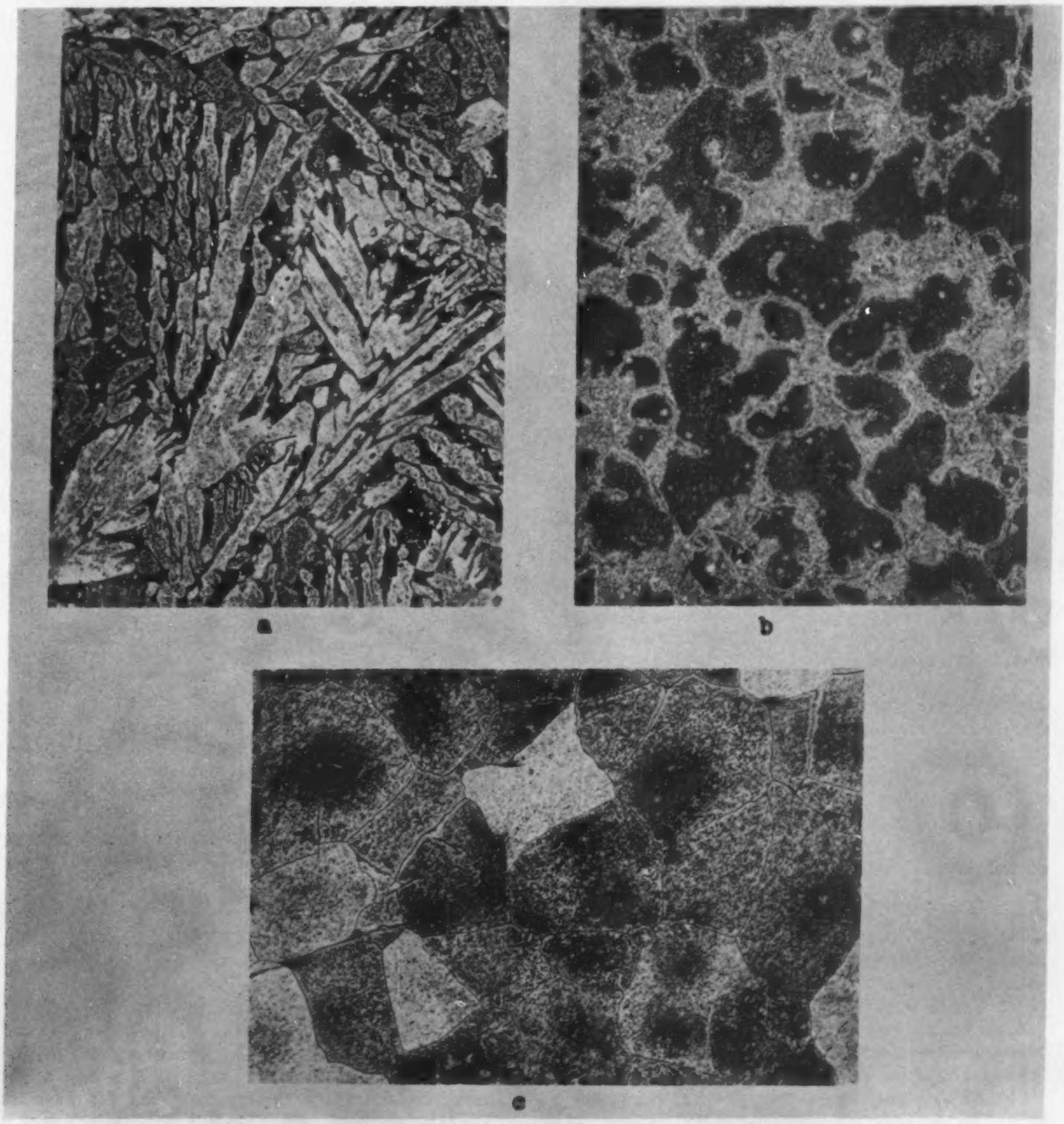


Fig. 2 — Representative photomicrographs of experimental Ni-Al bronze propeller patches in the as-cast condition. (a) Weldable yard foundry patch casting, (b) original, damaged ship's propeller casting and (c) yard foundry patch casting which cracked upon welding. NH_4OH and H_2O_2 etch. 120 ×.

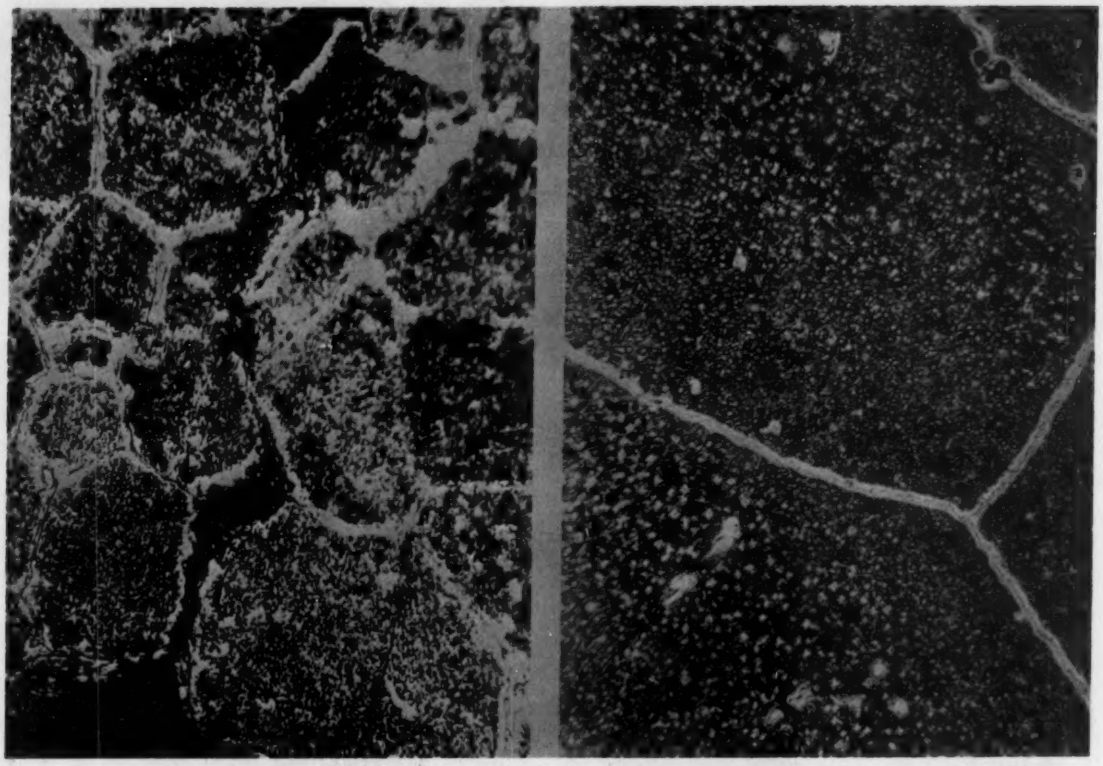


Fig. 3 — Photomicrograph of yard foundry as-cast Ni-Al bronze which consistently cracked upon welding. Item F-1, Table 1. *Right* — casting. *Left* — heat affected zone near weld. NH_4OH and H_2O_2 etch. 500 ×.

Of course, the degree of this significance remained to be established by more extensive tests.

Rockwell B hardness values for the several samples, listed in Table 1, indicate that the unweldable structure is softer than the ones which welded without difficulty.

During the progress of the preliminary experimental work several specimens of nickel-aluminum bronze of varying degrees of weldability were received from an industrial firm which uses this alloy type in the manufacture of cast propellers. While the samples were furnished with no other data than performance in welding, they were used to derive additional information for possible correlation of microstructure and tramp elements with weldability. The sample material available was insufficient for a complete chemical analysis.

Spectrographic Analyses

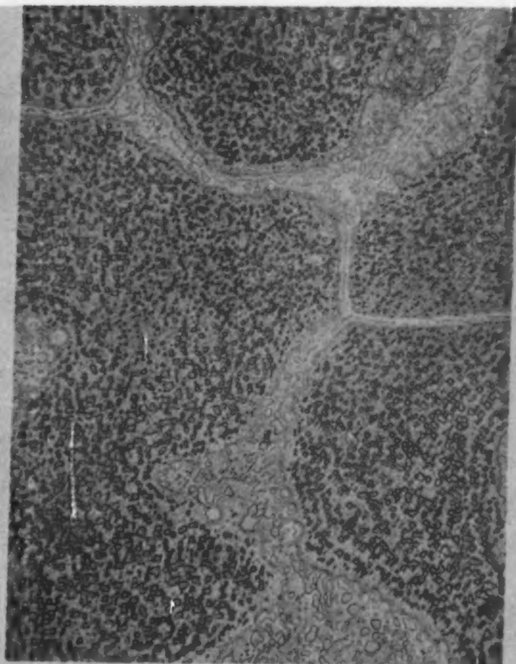
Table 1 lists the results of spectrographic analyses for impurity elements (Pb, Sn and Si) and Rockwell B hardness tests for five samples of the above material (items G, H, I, J and K) against weldability, as indicated by the source of supply. Figure 4 shows representative microstructures for four of these samples. The structure of item G resembles Fig. 2a, and is therefore not shown again.

The results for the proprietary samples do not agree completely with trends indicated by data obtained for the Shipyard foundry samples, and thus raised a number of questions to be resolved. Samples I and H, which have equivalent hardness ranges, comparable impurity content and somewhat similar (nearly single phase) microstructures, show good and bad weldability, respectively. The difference in sharpness of the grain boundary material, which remained to be identified, was expected to hold a clue to the difference in weldability reported. Samples H and J appear to bear out the trend indicated by comparable data for Shipyard foundry samples.

Their lead contents are high, hardnesses are low and structures are similar to those for the foundry material (Fig. 3) and all cracked on welding. Sample K, with highest lead content of all samples considered (i.e. 0.15 per cent), intermediate hardness and a "good" microstructure cracked slightly without peening but welded satisfactorily with peening.

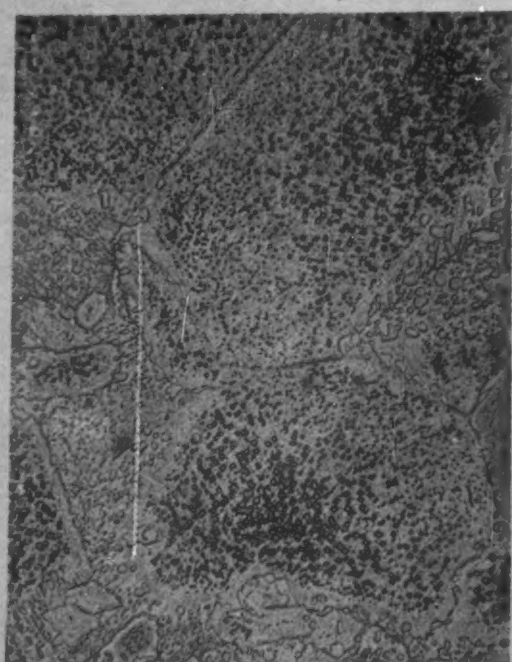
In order to eliminate the possible effects of tramp elements on weldability, it was decided to run subsequent heats with material carefully screened for low Pb, Sn and Si. The heats were calculated to contain Al, Fe, Ni and Mn at levels of about 10, 4, 5 and 1 per cent, respectively, which were estimated to be comparable to the optimum composition for hot worked alloy reported by Cook, Fentiman and Davis,[3] i.e., Al, Fe and Ni at levels of 10.5, 5 and 5 per cent, respectively. Representative data for heats of this type are indicated as items L and M in Table 1.

The hardnesses compare favorably and the tensile strengths are somewhat lower than for the weldable



(ITEM H)

(ITEM J)



(ITEM I)

(ITEM K)

Fig. 4 — Representative microstructures for proprietary cast Ni-Al bronze samples. Items H, I, J and K, Table 1. NH_2OH and H_2O_2 etch. 500 ×.

alloys, items B, C, and D. The microstructures of these heats are shown in Fig. 5. It is interesting to note that while both materials (items L and M) were weldable, there is a pronounced difference in the microstructures which could not be explained at the time.

Preliminary Trends

On the basis of this limited data reported for cast Ni-Al bronze, the preliminary trends indicated were as follows:

1) Impurity content (Pb, Si, Sn, etc.) may adversely affect weldability, but is not the sole factor involved.
2) Microstructure is an important factor related to weldability.
3) A "weldable" microstructure is dependent on a critical composition range.

In addition, it was considered that the cooling rate during solidification has an effect on the microstructure, and that for each nominal composition there may be a critical cooling rate range which produces a weldable structure.

Since the indications from this limited work were recognized to be trends at best, and since, in addition, they revealed unexplainable anomalies, it was considered that a more extensive investigation was justified, so that while the advantages of the alloy could be realized, the difficulties of the inconsistent weldability and fabricability could be reduced to a minimum. Accordingly, the Material Laboratory requested the Bureau of Ships to sponsor a formal investigation to establish firm trends and to resolve anomalies indicated by its preliminary work.

The project was actually authorized at the end of 1957. The importance of this work has since been highlighted by reports in the literature,[8,9] which shows an increased interest in and use of this cast alloy type and suggests that improvement in weldability to obtain consistent repairability is needed. With regard to welding, the latter report, for example, states "the know-how for welding aluminum bronze (which includes the type with nickel) is gradually being acquired though there have been difficulties to overcome in the process."

The overall objectives of this investigation were:

1) To determine the composition limits which yield a weldable structure under various jobbing foundry melting conditions, with considerations of effects of impurities, mass and microstructure on weldability.
2) To develop suitable heat treatments to convert unfavorable as-cast structures to structures which can be welded consistently without difficulty.

The current progress report deals primarily with aspects which fall under the first objective.

EXPERIMENTAL PROCEDURE

The experimental procedure used in this investigation was designed to supplement related work already published, or known to be in progress on the relationship between weldability and composition of as-cast nickel-aluminum bronzes, by (a) introducing considerations of the effect of mass (or cooling rate) and (b) obtaining data which could be useful in design, production and salvage operations.

In order to avoid contamination with tramp elements, the sample material for each composition studied was made from ingot prepared from virgin materials at the Shipyard Foundry. The desired and actual compositions of the ingot material made are:

Element	Desired, %	Actual, %
Aluminum	8.0	8.2
Nickel	5.0	5.1
Iron	4.0	4.0
Manganese	0.5	0.5
Copper	Rem.	82.2

This ingot material was used to cast seven heats varying in aluminum content from 6 to 12 per cent. Table 2 shows the expected and actual analyses, as determined from test bar coupons for each of the heats.

A uniform foundry practice was adopted and maintained for all heats in this investigation, in order to keep random variables to a minimum. The molds were prepared from a sand mixture which was similar to that used for steels in the Shipyard Foundry, and which had the following formulation:

Silica Sand, AFS Fineness 53-65, lb	630
Western Bentonite, lb	24
Dextrin, lb	11
Washing Soda, oz	2
Moisture, % by wt.	3.5

The dry components were mulled for 4 min. The water was added through the machine spout while mulling, and mulling was continued for an additional 2 min. Preformed sprues, gates and risers were used in all cases, as shown in Figs. 6 and 7. Each mold was dried for 8 hr at a temperature of 450 F in a gas-fired mold drying oven, coated with zircon wash to minimize mold-metal reactions and redried for an additional 5 min prior to use. A 600 lb oil-fired furnace was used in melting.

A slightly oxidizing atmosphere was maintained by careful manual control of the air to oil mixture throughout the melting cycle. The tapping and pouring temperature ranges were 2170 to 2200 and 2050 to 2100 F, respectively, as checked with a calibrated immersion chromel-alumel pyrometer. A commercial neutral flux consisting primarily of $3NaF \cdot AlF_3$ plus NaF was added prior to tapping in amounts of one lb/100 lb of charge and thoroughly mixed. The additions for obtaining graded increases in aluminum were made in the furnace just prior to tapping, with an allowance of from 5 to 10 min for homogenization of the melt.

As noted previously for the preliminary work, no external deoxidant was used since it is considered unnecessary for alloys at the level of aluminum involved in this alloy type. A hot top compound was used to

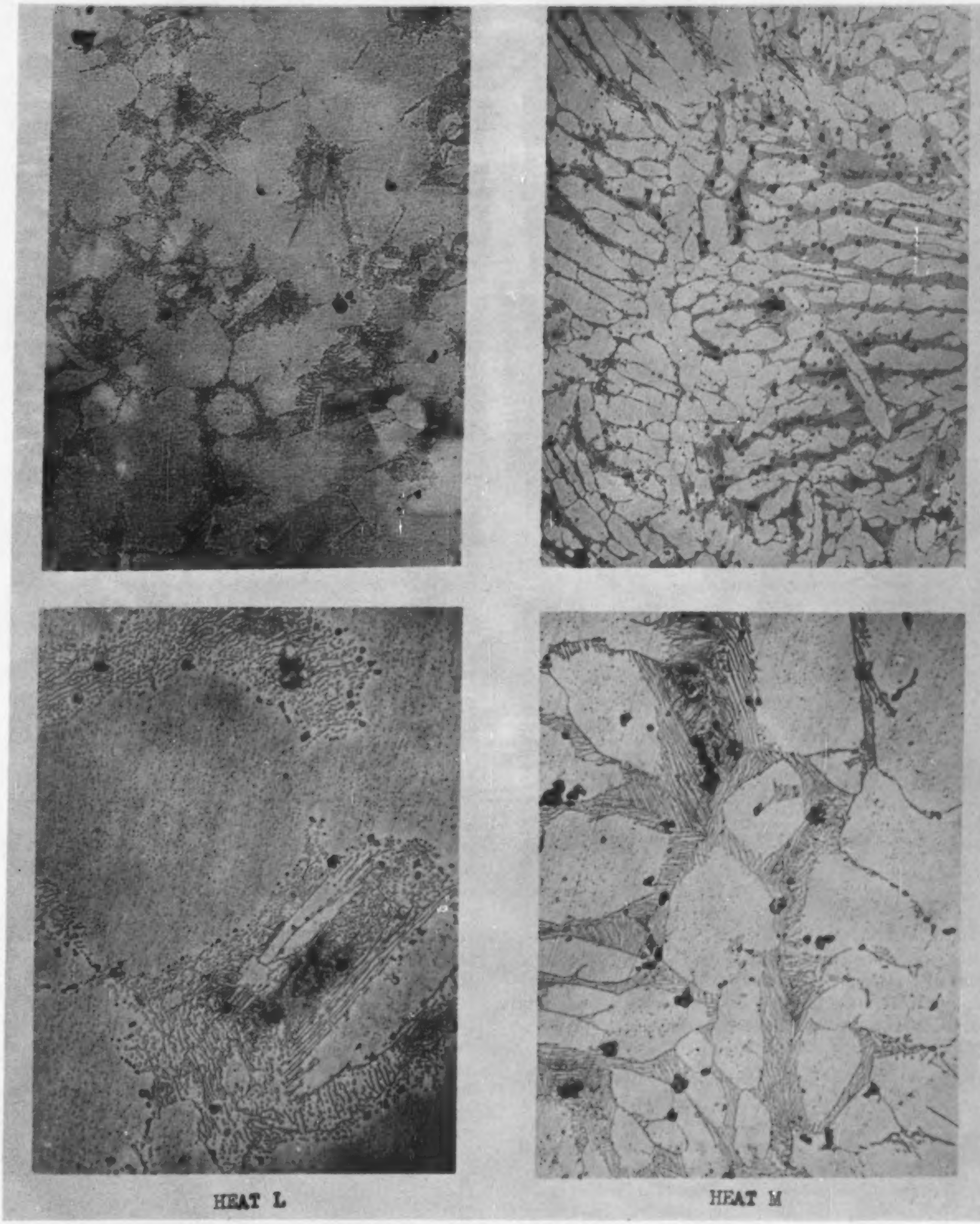


Fig. 5 — Photomicrographs of weldable, composition-adjusted yard foundry cast Ni-Al bronze heats. Items L and M, Table 1. NH_4OH and H_2O_2 etch. ***Top*** **— 120 ×.** ***Bottom*** **— 500 ×.**

TABLE 2 — ALUMINUM CONTENT EFFECT ON MECHANICAL PROPERTIES OF SEPARATELY CAST Ni-Al BRONZE BARS

Heat No.	Analysis	Composition, % Cu	Al	Ni*	Fe*	Mn*	Pb*	Yield Point, psi	Tensile Strength, psi	Elong., % in 2 in.	Bhn Avg., 3000 kg Load
								30,400	75,000	33.0	
	Expected	84.4	6.0	5.0	4.0	0.50	—	30,200	73,600	33.5	
1								31,400	74,800	34.0	121
	Actual	84.9	5.9	4.5	4.1	0.44	0.02	33,500	75,500	31.0	
								31,400 Avg.	74,800 Avg.	32.9 Avg.	
								34,200	83,600	26.0	
	Expected	83.3	7.0	5.0	4.0	0.50	—	33,600	81,600	26.0	
2								32,400	77,500	28.0	131
	Actual	83.9	7.0	4.5	4.1	0.41	0.02	38,800	75,100	27.0	
								34,800 Avg.	79,500 Avg.	26.9 Avg.	
								44,600	82,800	18.5	
	Expected	82.4	8.0	5.1	4.0	0.50	—	44,000	86,500	22.0	
3								47,000	81,500	13.0	143
	Actual	82.6	8.3	4.7	4.2	0.39	0.04	40,500	89,600	22.0	
								43,000 Avg.	85,000 Avg.	20.8 Avg.	
								45,200	78,200	8.5	
	Expected	81.3	9.1	5.1	4.1	0.50	—	42,000	94,300	23.5	
4								42,600	93,900	21.1	156
	Actual	81.4	9.2	4.8	4.4	0.37	0.00	43,400	93,400	21.0	
								42,700 Avg.	93,700 Avg.	21.8 Avg.	
								46,400	94,400	15.0	
	Expected	80.7	9.8	5.0	3.9	0.49	—	48,000	99,000	15.0	
5								47,600	92,400	13.0	170
	Actual	80.9	10.0	5.0	4.2	0.37	0.02	46,700	95,000	15.0	
								47,200 Avg.	95,200 Avg.	14.5 Avg.	
								55,500	97,500	3.5	
	Expected	79.6	11.0	5.0	4.0	0.48	—	56,500	94,000	3.0	
6								59,500	93,600	2.5	217
	Actual	79.8	11.1	4.9	4.3	0.36	0.01	57,000	92,500	3.0	
								56,300 Avg.	94,000 Avg.	3.0 Avg.	
								69,000	95,500	1.5	
	Expected	78.8	11.8	4.9	3.8	0.48	—	67,500	78,500	1.0	
7								71,000	98,200	1.0	241
	Actual	79.1	11.9	4.8	4.3	0.35	0.01	67,800	74,600	0.5	
								70,000 Avg.	96,900 Avg.	1.0 Avg.	

* Spectographic analysis.

cover the wedge casting risers. Castings were permitted to remain in molds overnight in all cases.

For each composition considered, two wedges and two conventional keel blocks were cast. Figures 8 and 9 are photographs showing the design of the wedge used, including dimensions of the sprue, runners, gates and risers. The keel block was prepared in accordance with Fig. 1 of the applicable specification for nickel-aluminum bronze castings.[10] The test material was used as follows:

A) *Keel Blocks.* These provided a total of four, 0.505 in. unthreaded tensile bars for determining mechanical properties. Representative samples for microscopic examinations were prepared from end portions of the tensile bars.

B) *Wedges.* One wedge was cut into three equal parts, along the 12 in. length, and marked A, B, and C for the nearest, middle and furthest portion with relation to the down sprue, respectively. The second wedge was used for groove weld specimens.

Portion A was used for a surface weld-bead test as a preliminary method for screening out as-cast material with extremely poor weldability. Figure 10 is a sketch of this portion of the wedge showing the direction in which the beads were applied. It will be noted that this procedure was designed to take into account (a) differences in extent of heat affected areas, (b) section thickness and (c) the nature of the surface, i.e., whether it was as-cast or machine cut.

The weld rod used was stranded, $\frac{5}{64}$-in. diameter, aluminum-bronze wire, designed to give an overlay bead of 300 Bhn. The inert gas (argon) process was used, and the welding was performed at approximately 60 volts DC and 240 amps. The completed samples were inspected by dye penetrant method for cracks on the surface and on cross-section parallel to the base, at $1\frac{1}{4}$-in. intervals, from the thin to the thick edges of the wedge.

Portion B was saved for subsequent use in hot bending tests, which will be reported in the next phase of this work.

Portion C was used to prepare Charpy V-notch specimens. A sketch of the wedge showing the location of the specimens and the orientation of the notch is shown in Fig. 11. Charpy V-notch specimens were tested at three temperatures:

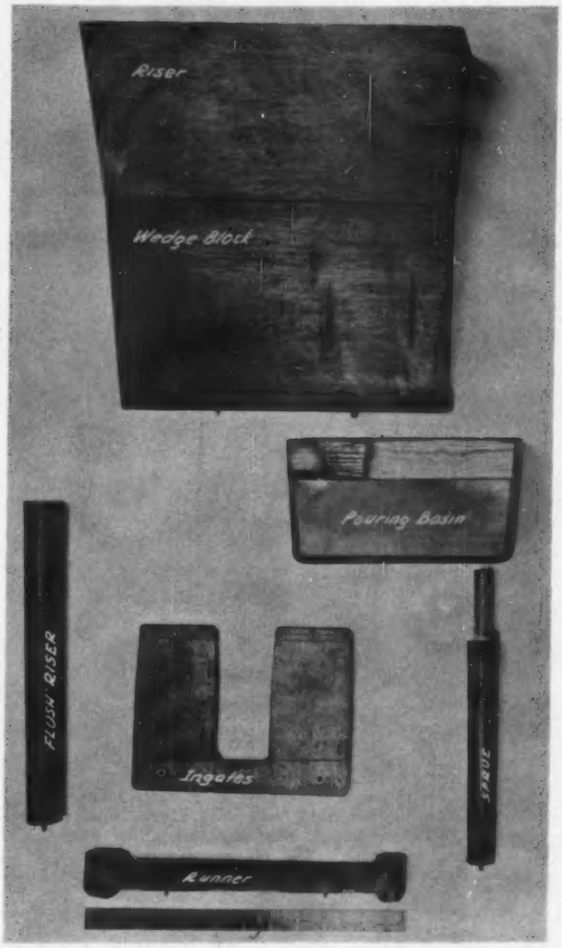


Fig. 6 — Components of preformed gating and risering system used for wedge casting.

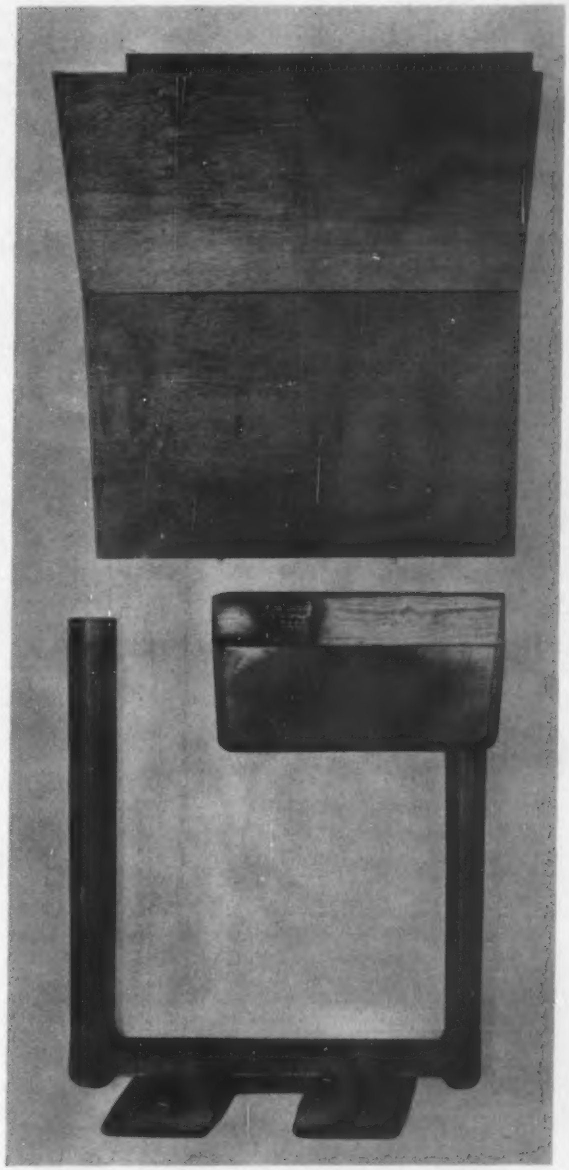


Fig. 7 — Assembled view of preformed gating and risering system used for wedge casting.

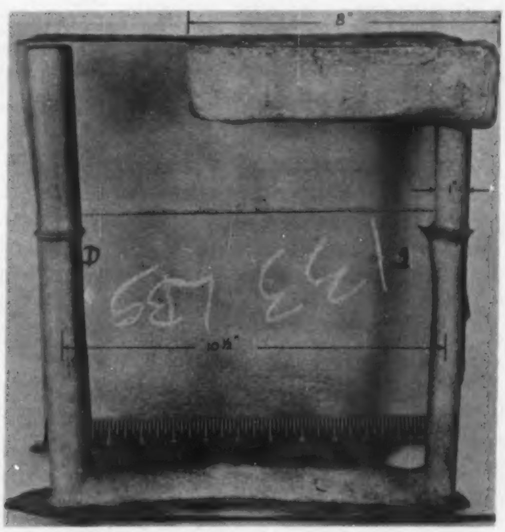


Fig. 8 — Front view of wedge casting.

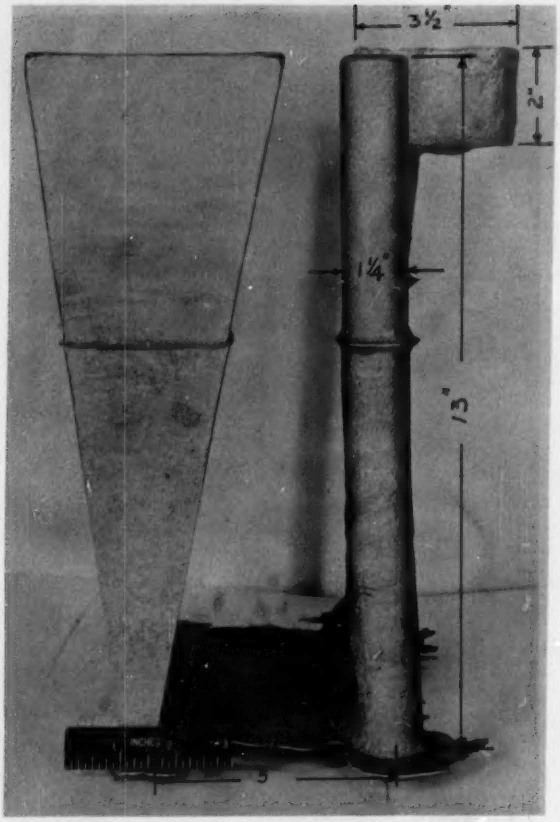


Fig. 9 — Side view of wedge casting and gating arrangement.

Specimen No. or Location	Test Temp., F
1, 3, 7	0
0, 4, 9	75
2, 5, 6, 8	180

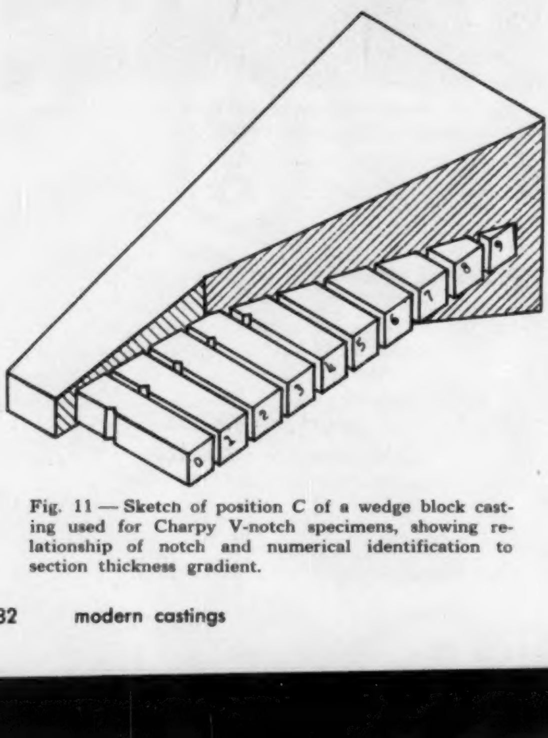


Fig. 11 — Sketch of position C of a wedge block casting used for Charpy V-notch specimens, showing relationship of notch and numerical identification to section thickness gradient.

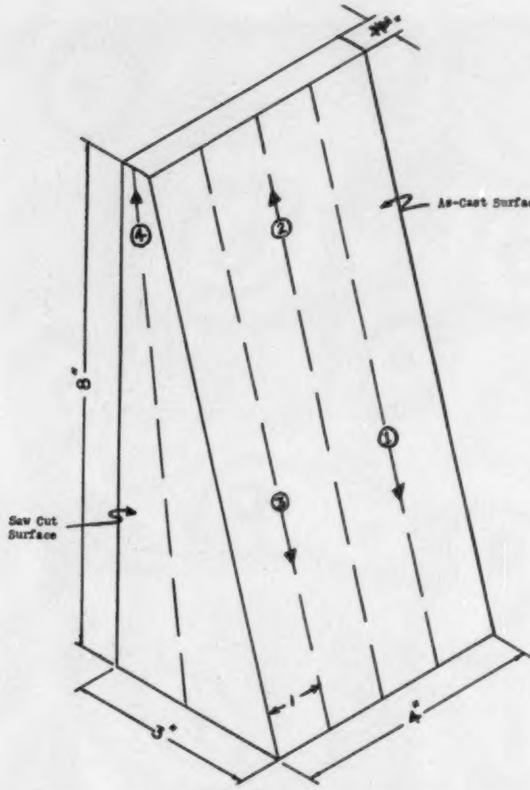


Fig. 10 — Sketch of position A of a wedge block casting used in surface weld bead tests. Labled lines show order and direction of bead application. All surfaces, except as otherwise noted, are as-cast.

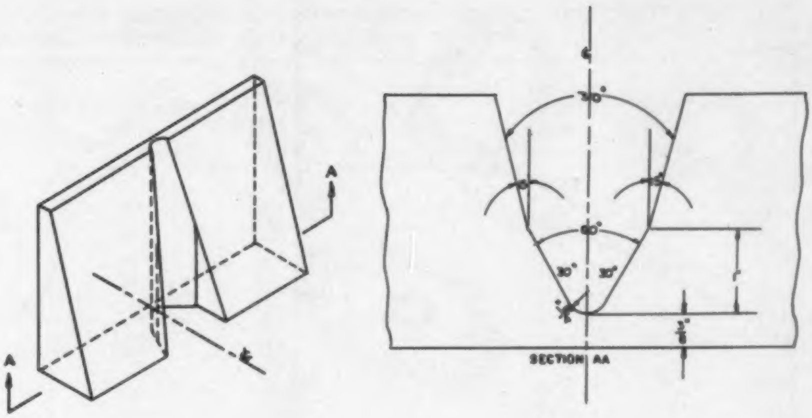
It is to be noted that the specimens for test at a particular temperature were selected from staggered locations to take into account the variation in wedge thickness. The specimens were broken in a 220 ft-lb impact testing machine under a striking velocity of 18.1 fps.

Groove Welding

Figure 12 is a sketch of the groove weld specimen made from the second wedge. One of the machined wedges prior to welding is shown in Fig. 13. It will be noted that the specimen provides for the influence of mass effect as well as progressively increased restraint as welding proceeds. The degree of restraint is considerably greater than involved in other related work reported in the literature, and is of the order of magnitude encountered in actual repair of propellers. This follows from the design of the wedge, in which the thickness variation is of the order of magnitude found in propellers, although the gradient is appreciable steeper.

The applicable welding details are as described for the weld-bead test. In the groove weld, no preheat was used, and the beads were deposited in a continuous manner except that deposition was interrupted when the base metal temperature was above 200 F. The completed weld specimens were cooled in still air and inspected by dye penetrant and radiography to evaluate soundness. They were next cut to provide

Fig. 12 — Sketch showing design of the groove used for groove weld test blocks.



flat tensile and bend specimens, as shown in Fig. 14a. To obtain these specimens, the reinforcement portion of the base metal was first cut off. In this manner, each specimen was cut so as to contain all weld metal in the section under test.

The tensile and bend specimens were prepared, as shown in Fig. 14b, in accordance with the applicable drawing of the current Federal Test Method Specification.[11] X-ray diffraction phase studies were made on samples of several heats to supplement metallographic examination, and to determine significant differences in phases and amounts which could be associated with degree of weldability. The details of the method employed will be submitted in the next progress report.

Subsequent to this work, three additional 1000 lb heats were cast using a foundry practice similar to that described previously, with the exception that a different flexing agent was used. The latter was a proprietary mix tried for the first time on this alloy type. The basic composition of these heats was that indicated in the work described below as being optimum insofar as major elements are concerned, i.e., 10 per cent Al, 4 per cent Fe, 5 per cent Ni and 0.5 per cent Mn.

One heat was used as a control, i.e., with no additions of Si and Pb. The second heat was subdivided into four portions with silicon at four levels ranging from 0 to 0.18 per cent. The third heat was also subdivided into four portions, and made to vary in Pb content from 0 to 0.10 per cent. For each composition, one wedge and one keel block was cast. Each wedge was prepared for groove welding as previously described.

Experience gained in the preliminary work on weld repair of Ni-Al bronze propellers showed that wherever castings contained gross internal defects cracking occurred on welding. The presence of even fine stringers of dross at the surface gave similarly bad results on welding. To assist in subsequent interpretation of weldability data, it was therefore decided to use radiography (radium) and dye penetrant tests to check the overall soundness of the wedge castings before and after groove welding.

It was not anticipated that radium radiography of the relatively thick section would reveal more than major discontinuities in the unsectioned wedges (cast or welded). On the other hand, it was expected that penetrant inspection would be helpful in highlighting dross and fine cracks coming to the surface on the welded wedges as a whole, and in the course of examination of sections prepared for more detailed studies.

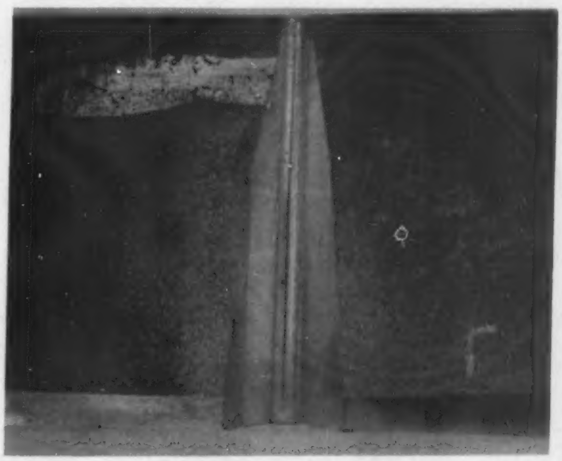


Fig. 13 — Groove weld test specimen.

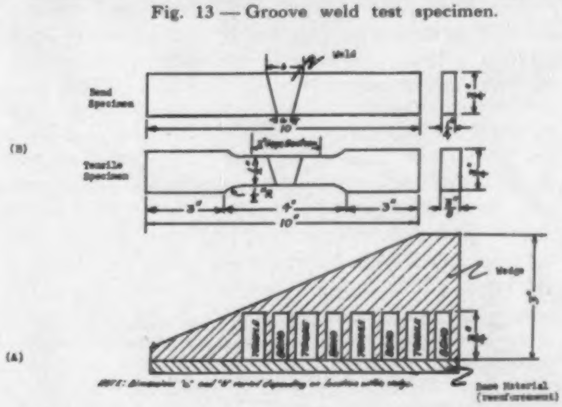


Fig. 14 — Sketch showing location and dimensions of tension and bend specimens taken from groove welded test block.

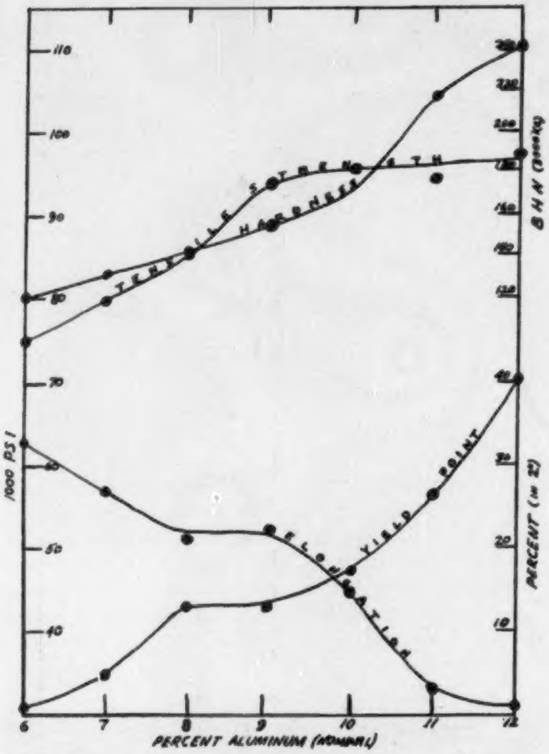


Fig. 15 — Aluminum content effect on mechanical properties of as-cast nickel aluminum bronze (5 per cent Ni, 4 per cent Fe and 0.5 per cent Mn). Yield point determined by divider method using 2 in. gage.

RESULTS

Figure 15 is a plot of mechanical properties (tensile and hardness) vs. aluminum content for separately cast test coupons, based on the data given in Table 2. In general, as the aluminum content increases, the strength and hardness tend to increase while the elongation decreases. It is to be noted, however, that the plots of tensile strength, yield point and elongation show sharp changes in slope between approximately 8 to 10 per cent Al.

The relationship between hardness and tensile strength is shown in Fig. 16. It will be noted that there is a linear increase in strength up to a Bhn (at 3000 kg) of approximately 165, after which fur-

TABLE 3 — V-NOTCH CHARPY VALUES VS. ALUMINUM CONTENT IN AS-CAST Ni-Al BRONZE

		0 F		75 F		180 F	
Heat No.	Al, %	Sample No.	Ft-Lb	Sample No.	Ft-Lb	Sample No.	Ft-Lb
		1	49	0	47	2	44
1	6	3	51	4	45	5	49
		7	53	9	52	6	50
						8	51
	Avg.		51		48		49
		1	43	0	42	2	40
2	7	3	43	4	42	5	46
		7	49	9	47	6	48
						8	47
	Avg.		45		44		45
		1	23	0	25	2	25
3	8	3	24	4	26	5	24
		7	23	9	25	6	26
						8	26
	Avg.		23		25		25
		1	18	0	19	2	20
4	9	3	18	4	19	5	20
		7	17	9	27	6	17
						8	19
	Avg.		17		22		19
		1	18	0	19	2	21
5	10	3	17	4	18	5	19
		7	17	9	17	6	19
						8	19
	Avg.		17		18		20
		1	12	0	13	2	13
6	11	3	8	4	10	5	10
		7	10	9	9	6	—
						8	9
	Avg.		10		11		11
		1	2	0	3	2	2
7	12	3	2	4	3	5	2
		7	3	9	3	6	4
						8	3
	Avg.		2		3		3

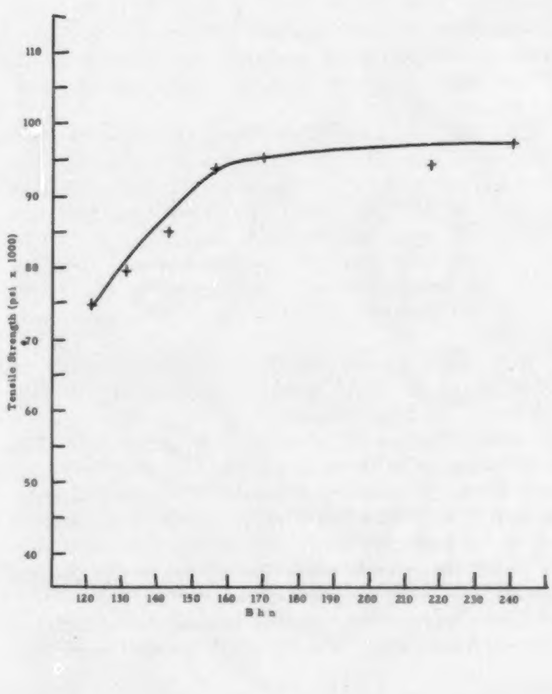


Fig. 16 — Brinell hardness number vs. tensile strength for as-cast Ni-Al bronze (Base on data of Table 2 and Fig. 15).

TABLE 4 — EFFECT OF ALUMINUM ON MECHANICAL PROPERTIES OF AS-CAST WELDED NICKEL ALUMINUM BRONZE

		Tension Tests on Welded Specimens				Bend Tests on Welded Specimens		Dye Penetrant Inspection of Tensile and Bend Specimens	Weld Bead Test	Overall Weld-ability
Heat No.	Al, %	Y.S.,[5] psi	T.S., psi	Elong., % on 2 in.[2]	Location of Bar Fracture	Bend degrees[4]	Location of Bar Fracture			
1	6[3]	—	—	—	—	—	—	Cracked	Cracked	NG
		—	12,700	—	Heat		Heat			
2	7	15,800	16,300	—	Affected	13.0	Affected	Cracked	Cracked	NG
		15,000[1]	15,500[1]	—	Zone		Zone			
		17,100	18,700	—						
		37,600	41,700	3.0	Heat		Heat			
3	8	35,300[1]	37,400[1]	3.0	Affected	33.0	Affected	Cracked	No	NG
		36,000	36,200	2.0	Zone		Zone		Cracks	
					Heat					
4	9	45,600	63,700	3.0	Affected	47.0	Weld	No	No	OK
		47,400	55,700	1.5	Zone			Cracks	Cracks	
		42,600	70,400	6.0	Weld					
5	10	42,500	74,100	6.5	Weld	58.0	Weld	No	No	Optimum
		43,400	75,600	6.0	Base Metal			Cracks	Cracks	
		46,000	70,600	3.0	Weld					
6	11	47,400	76,400	2.0	Base Metal	26.6	Weld	No	No	OK
		48,700	74,000	3.0	Weld	27.6	Fusion Zone	Cracks	Cracks	
7	12[6]	—	—	—	—	—	—	—	No Cracks	NG

NOTES:
1. Low values due to unsound specimens.
2. Values not reliable due to difficulty in properly meshing fractures.
3. No specimens could be obtained due to excessive cracking along fusion zone during welding.
4. The angle of bend is considered as the deflection from the horizontal when fracture occurred.
5. 0.5 per cent Extension under load (2 in. gage length).
6. No specimens could be obtained due to excessive cracking of low ductility, high hardness base metal during welding.

ther increases in hardness yields practically no significant increase in strength. This suggests that up to a hardness of about 165 Bhn the tensile strength of the alloy may be estimated from the hardness, regardless of composition.

The effect of aluminum content on the microstructure of nickel-aluminum bronze is shown in Fig. 17. At the lower levels of Al, the structure appears to consist essentially of a single phase matrix with small amounts of precipitated intermetallic constituent. As the Al content increases, a two phase polygonal structure develops, and at levels of over about 10.5 per cent the structure assumes a martensitic form (similar to that found in steels).

Table 3 lists Charpy V-notch data as a function of Al content, for temperatures of test and sample position in the wedge casting as noted. The effect of the original section thickness, as determined by location of the Charpy V-notch specimen, for several levels of aluminum, is shown in Fig. 18. It is to be noted that the aluminum content has a marked effect on the absorbed energy, but for any given level of aluminum specimen location or test temperature have no significant effect on toughness.

Aluminum Content Effect

The effect of aluminum content on Charpy V-notch properties, regardless of sample location or temperature of test, is shown in Fig. 19. From this plot it can be seen that as the aluminum content increases there is a general decrease in energy value. Between 8 and 10 per cent aluminum there appears to be marked change in slope of the curve, which shows itself as a plateau at about 20 ft-lb, followed by a linear decline in energy absorbed above 10 per cent aluminum.

Table 4 contains a summary of weld-bead tests, and tensile and bend data for specimens machined from groove welded wedge castings at various levels of aluminum content. It should be noted that neither radiography nor dye penetrant inspection before welding revealed significant discontinuities in this series of wedges. The results of dye penetrant inspection of specimens cut from the wedges and comments on overall weldability are also included. The results show that the surface weld bead test is less discriminating than the groove weld test.

It will be noted that even the wedge materials which are considered weldable have somewhat lower tensile properties (as welded) than the corresponding separately cast tensile bars (Table 2). Among the weldable compositions shown the specimens representing the 9 and 10 per cent Al levels have the best ductility as evidenced by the angles of bend.

Figure 20 shows microstructures of welded samples with Al varying from 6 to 11 per cent, at original magnifications of 50 and 500 ×. At the lower aluminum content levels, namely from 6 to 8 per cent, it will be noted that cracks are visible in the base metal and appear to be intergranular. No cracks are visible in the samples containing 9 per cent aluminum and above for which, in addition, a better "knitting" of the structure is indicated in the fusion zone.

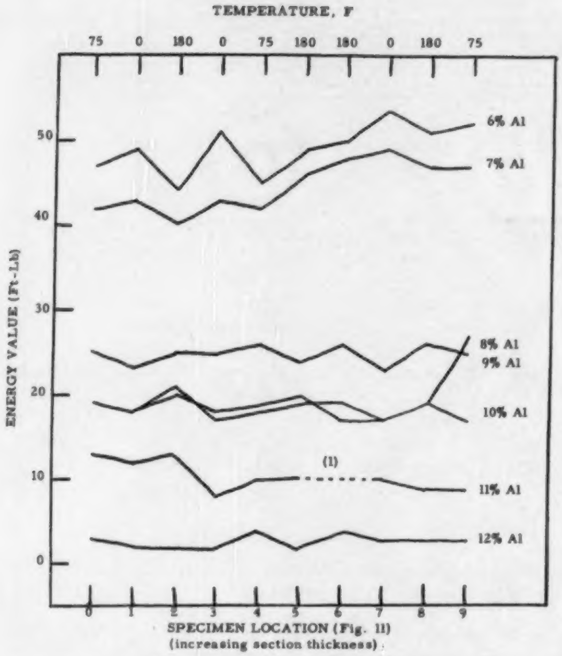


Fig. 18 — Test temperature and section size effect on the Charpy V-notch properties of as-cast Ni-Al bronze (note: (1) — defective specimen, not tested).

Fig. 19 — Aluminum content effect on Charpy V-notch properties of as-cast Ni-Al bronze (points indicated are averages).

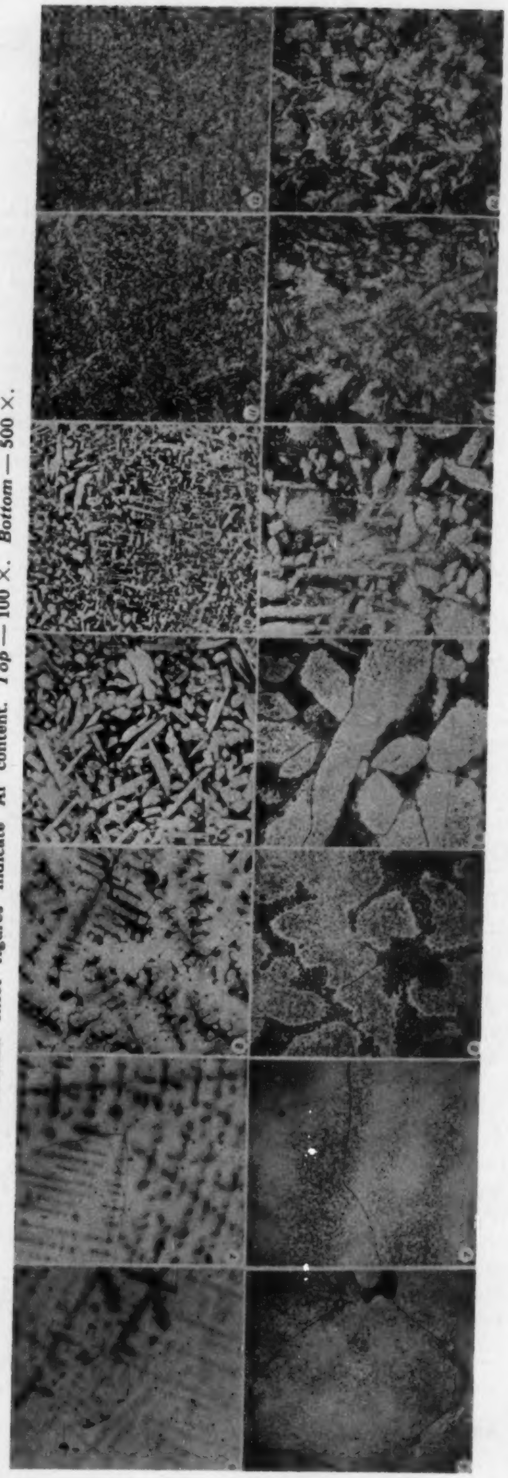


Fig. 17 — Typical as-cast Ni-Al bronze microstructure with increasing aluminum content. Inset figures indicate Al content. *Top* — 100 ×. *Bottom* — 500 ×.

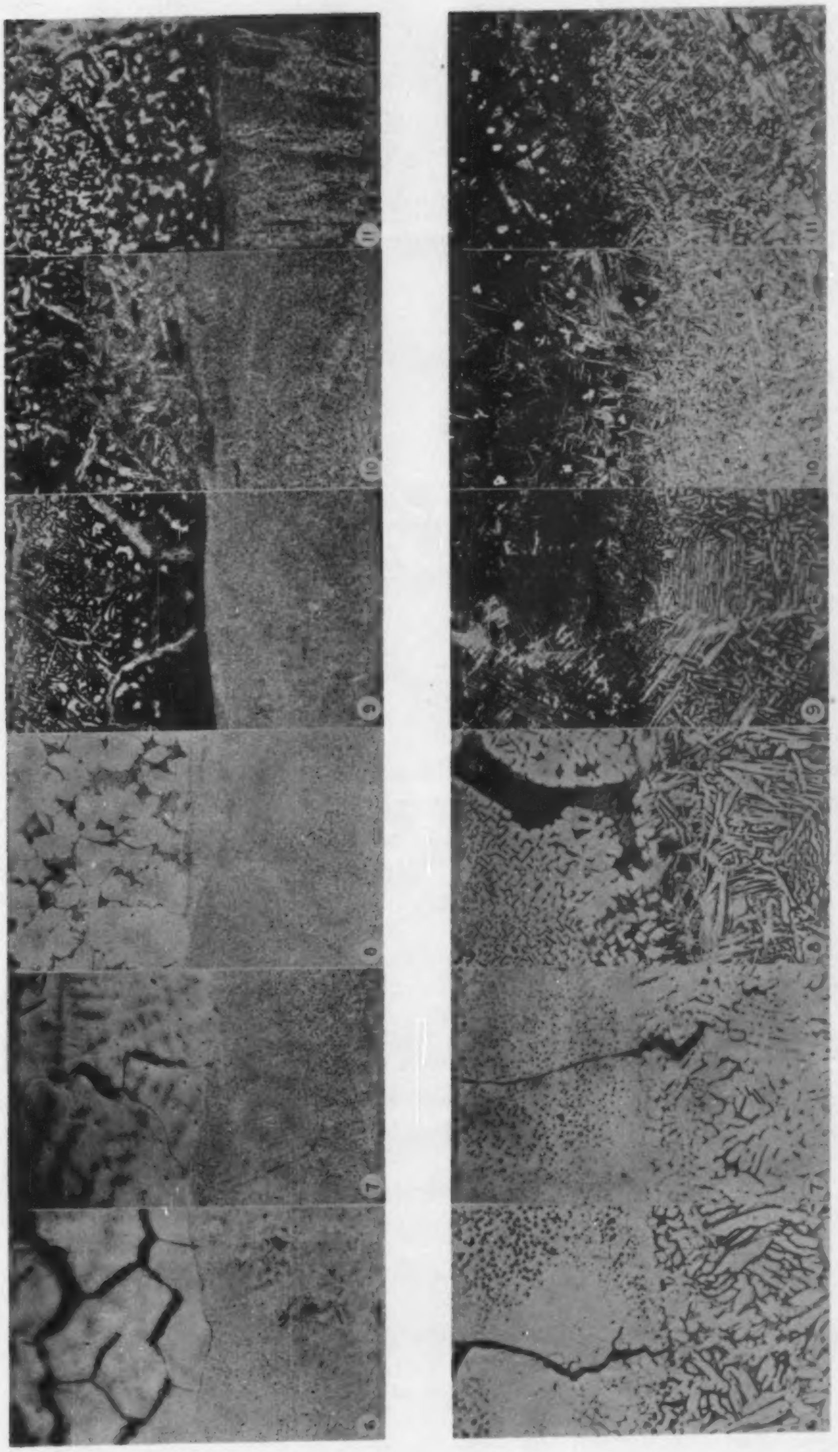


Fig. 20 — Representative microstructures at junctions of base-to-weld metal for as-cast Ni-Al bronze compositions varying in Al content. Per cent Al shown in inset figures. *Top* — 50 ×. *Bottom* — 500 ×. Reduced ½ photographically. Weld metal is at lower half in each photomicrograph.

Fig. 21 — Macrostructures of gage sections of tensile specimens taken from groove welded castings (per cent Al shown by inset figures) enlarged 2½ times.

Macrostructures of the gage sections of some of the welded tensile specimens are shown in Fig. 21 for specimens varying in Al content from 7 to 11 per cent, as indicated on the macros. It is to be observed that the 7 per cent Al sample shows numerous cracks in the base metal. Similar finer cracks, but less extensive, were observed in the base metal adjacent to the fusion zone in the 8 per cent Al sample, but these are not readily visible in the photomacrograph. For actual evaluation, dye penetrant inspection was used to facilitate crack detection in the macrosections, and trends were further checked by microscopic examination.

Most specimens contain gas pockets in the weld metal in varying degrees of severity. It is interesting to note that the grain size of the 8 per cent Al alloy is significantly smaller than that of the others. The macro for the specimen representing the 9 per cent Al alloy shows an irregular weld area, which was due to unsymmetrical backchipping and rewelding. The latter procedure was sometimes resorted to in the preparation of the groove weld specimens, in line with accepted production techniques, when the thin base metal backing material cracked because of mechanical restraint.

Pb and Si Effect

The effects of additions of Pb and Si to a weldable composition on subsequent weldability are shown in Table 5. Radiography of the wedges used in these tests showed excessive dross, which is considered to be due to the use of a previously untried flux. The weldability of this test material was therefore judged solely on the basis of dye penetrant indications and radiography applied to the wedges after welding as a whole. These data suggest that weldable structures are possible with Pb and Si as high as 0.10 and 0.18 per cent, respectively. These indications were confirmed by welders who reported that they encountered no trouble in the course of welding at these levels of so-called injurious elements.

TABLE 5 — Pb AND Si EFFECT ON WELDABILITY OF AS-CAST NICKEL ALUMINUM BRONZE (GROOVE WELDED SPECIMENS)

Heat No.		Lead	Silicon	Remarks
13		—	—	Weldable
14	A	—	0.04	Weldable
	B	—	0.08	Weldable[1]
	C	—	0.12	Weldable[1]
	D	—	0.18	Weldable
15	A	—	—	Weldable[1]
	B	0.06	—	Weldable
	C	0.09	—	Weldable
	D	0.10	—	Weldable

Avg. Analysis	
Cu	80.5
Al	10.2
Ni	4.7
Fe	3.6
Mn	0.47

1. Dye Penetrant revealed small surface cracks in the thin section of base metal back-up material.

DISCUSSION

Development of as-cast Ni-Al bronze compositions which yield satisfactory mechanical properties and consistent weldability requires determination of (a) the effect of major constituents on the mechanical properties, (b) the effect of composition on the microstructure, (c) the relationship of microstructure to weldability and (d) the effects of interaction, if any.

This portion of the investigation was limited to the study of the effects of varying amounts of aluminum (keeping the other specified elements at a substantially constant level within requirements of a reference[10]) on the mechanical properties, the resultant microstructures, and weldability. Lead and silicon were also considered, since impurities determine the cost and the acceptability of ingot material, and since their effects on weldability have raised many questions in the field.

This initial approach was taken as a result of previous work,[3,7] which had indicated that aluminum content was of prime importance in this alloy. Studies of the effects of the other major elements, i.e., nickel and iron, were planned as the next phase, using the optimum Al composition developed in the earlier work. Wedge block castings incorporating variations in Ni and Fe have been produced, but the balance of the work is not scheduled for continuation at present.

As-Cast Microstructures

The photomicrographs, shown in Fig. 17, may be divided into four distinct groups on the basis of the relative change in appearance of the structures, as the aluminum content increases from 6 to 12 per cent. These groups are:

Group	Aluminum, %
I	6 to 7
II	8
III	9 to 10
IV	11 to 12

Group I. The microstructures, for the 6 and 7 per cent aluminum levels are basically similar and contain a matrix composed of large alpha grains. The alpha phase is identified by x-ray crystallography as a random face-centered cubic lattice structure. Within the α grains and in the grain boundaries, there appear small amounts of a κ phase which is characterized by x-ray crystallography, as an ordered body-centered cubic lattice structure. This phase is composed of complexes of nickel, iron and aluminum and provides strength to the alpha matrix which is ductile and lacking in strength.

The combination of the two phases alpha and kappa in varying amounts and in orientation, will accordingly, yield a wide range of mechanical properties. At this level of aluminum, the kappa within the grains precipitates in a dendritic pattern with individual particles in globular form as revealed at higher magnification (Fig. 17). Between grains, the kappa is arranged in rod-like stringers which follow the grain boundary contours.

Group II. At 8 per cent aluminum, the microstructure shows an appreciable increase in the amount of kappa with a corresponding decrease in the primary alpha. Within the grains, the dendritic pattern of kappa is still evident at low magnification. The kappa in the dendritic skeleton appears largely as a precipitate of polygonal-shaped agglomorates within pure alpha. The kappa in these agglomorates is in the form of globules. The thin, rod-like kappa in the grain boundaries has greatly diminished in amount. The kappa within the alpha grains has increased in amount and is still in the form of a fine globular dispersion.

Group III. At 9 per cent aluminum, the appearance of the microstructure changes radically. The alpha matrix is now in the form of elongated finger-like grains in a Widmanstatten pattern. The kappa phase is still present in its fine spheroidal condition within the alpha grains. The grain boundaries now consist of transformation products of high temperature beta, similar in appearance to pearlitic structure in steel. The transformation products from the beta phase are secondary alpha with kappa in lamellar form (eutectoid). The rod-like formation of the kappa constituent coming from the primary alpha phase is still present, although in smaller amounts of shorter stringers.

In addition, the appearance of light gray spheroids was now observed. These spheroids are tentatively considered to be delta phase, which has been identified in samples containing 9 per cent Al by x-ray crystallographic work at the Laboratory. It is to be noted that this structure is not readily identified metallographically, and then only by tedious and differential etching techniques described in the literature.[3,12] Additional work planned to correlate more conclusively the optical and x-ray diffraction results on this point has not been started.

The microstructure of the 10 per cent aluminum alloy is basically similar to the 9 per cent alloy structure. The increase in aluminum content is accompanied by a decrease in the amount of alpha, and a corresponding increase of the eutectoid composition. The Widmanstatten pattern is still prevalent, and the finger-like grains of alpha are smaller and more randomly scattered. The primary alpha grains contain some precipitated kappa. Secondary alpha precipitate appears at the grain boundaries. In addition, the alpha plus kappa lamellar structure has increased in amount and the globules (or rosettes) of delta are now larger.

Group IV. At the 11 and 12 per cent aluminum levels, the microstructure changes from an essentially alpha matrix (Group I) to a matrix of beta transformation products and retained high temperature beta constituent. In contrast to the microstructures of the lower aluminum level alloys, the 11 and 12 per cent aluminum types show little alpha phase, most of which is secondary alpha located at the grain boundaries. The amount of eutectoid composition appears to be at a maximum in the 11 per cent alloy, whereas the 12 per cent alloy has more retained beta which incidentally, is a hard and brittle constituent. Both alloy type structures contain rosettes or cubicles of delta. The overall structure resembles martensite.

Mechanical Properties vs. Microstructure

A study of the microstructure and mechanical properties indicates that there is a rational relationship between the two. The discussion which follows applies to microstructures and mechanical properties of separately cast tensile bars.

At low levels of aluminum, as the aluminum content increases the amount of kappa constituent increases, thereby increasing hardness and strength and reducing elongation. The curves (Fig. 15) for these properties vs. aluminum content bear out this explanation for the 7 and 8 per cent aluminum alloys. Between 8 and 9 per cent aluminum, the tensile strength and elongation curves exhibit significant changes in slope. On increasing the aluminum content beyond 8 per cent, the tensile strength continues to increase more rapidly but the elongation remains approximately constant, instead of dropping as might be expected from the usual relationship between strength and ductility.

This condition can be explained by careful study of the microstructure. It is considered to be probably due to the distribution and orientation of the kappa phase. In the 8 per cent Al alloy, the kappa is formed from the super-saturated primary alpha phase whereas in the 9 per cent Al alloy the kappa originates from the beta which transforms into lamellar plates of alpha plus kappa eutectoid. The ductility is not affected by the increase in kappa for the 9 per cent aluminum alloy (compared to the increase in tensile and hardness), because in this alloy the distribution of the phases is more random and hence more favorable to ductility. Above 9 per cent aluminum, the elongation falls off rapidly due to the increased retention of the hard and brittle beta constituent.

Figure 15 indicates a continued increase in hardness with a leveling off of tensile strength as the aluminum content increases from 9 to 12 per cent. That this increase in hardness takes place not only at the expense of ductility but of toughness as well, is shown by a plot of Charpy V-notch energy vs. per cent aluminum, Fig. 19. The approach to a practically constant tensile strength above 9 per cent aluminum is probably due to the formation of secondary alpha at the grain boundaries, which affect the strength more than the increasing amount of harder constituent within grains. The continued increase in hardness can be explained by the fact that resistance to indentation is a direct function of the hard material within the area of contact involved, which is increasing with aluminum content.

Aluminum content has a pronounced effect on the Charpy V-notch properties of nickel-aluminum bronze. The trend indicated for the Charpy data, Fig. 19, closely parallels that indicated by the plot for elongation, Fig. 15. In both plots, there appears to be a leveling off of the curves near the 9 per cent alumi-

num level. Figure 19 suggests nickel-aluminum bronze is relatively notch-insensitive to variations in Al content in the range of 8.5 to 10 per cent. While variation of aluminum within the range noted produces changes in geometrical size of constituents, these changes affect the elongation and Charpy value little.

Beyond 10 per cent aluminum, the toughness declines rapidly due to an increase in the brittle beta constituent. From Fig. 18 it can be seen that for any given aluminum content the toughness is practically independent of section size, from which the specimen was taken, or temperature at which specimen was tested, i.e., ½ to 3½-in. and 0 to 180 F, respectively.

Microstructure and Weldability

This discussion applies to specimens sectioned from groove welded wedge castings, which, according to Table 4, are more discriminating than the surface weld-bead test with regard to weldability. From Fig. 20, it can be seen that intergranular cracking of the base metal occurs for Group I (6 and 7 per cent Al) and Group II (8 per cent Al) alloys, the latter having less extensive cracking. It is interesting to note that cracking takes place along the thin rod-like kappa constituent, which is precipitated by the supersaturated alpha phase at the grain boundaries.

The tendency for cracking to occur in the grain boundaries is enhanced by the fact that the kappa phase is (a) more brittle than alpha, (b) essentially continuous and (c) oriented with respect to other phases so as to provide paths of least resistance to stress concentrations. At high aluminum contents, 9 to 11 per cent, the photomicrographs show a sound and complete "knitting" of the weld metal to the base metal. With increasing Al content, there is a "transition" in the region between 8 and 9 per cent, at which the base metal will bond properly with the weld metal and the susceptibility of cracking is lessened. The significantly smaller grain size observed for the 8 per cent Al macrospecimen (Fig. 21) compared to all others, appears to confirm that such a "transition" exists.

We therefore see that the low Al, nonweldable, alloys contain primarily alpha and kappa, the latter precipitating in thin, essentially continuous stringers at grain boundaries from a supersaturated alpha solution. On the other hand, the higher Al, weldable, alloys contain alpha plus kappa (beta transformation products) with retained beta and some delta.

While the alpha plus kappa alloys are superior to the alpha-kappa (eutectoid) plus beta alloys, as far as room temperature ductility is concerned, the situation is reversed at the temperatures of welding. In other words, the alpha plus kappa alloys are hot short and have a tendency to crack while the alpha-kappa (eutectoid) plus beta alloys show good hot ductility, which is necessary for successful welding. Under ideal and practically unattainable conditions it would be desirable to have an all beta structure at elevated temperatures, and an all alpha plus kappa structure at room temperature.[18]

For practical purposes, it follows then that for consistent weldability a composition must be selected which has enough beta at welding temperatures for hot ductility, and enough alpha plus kappa on cooling to room temperature for cold ductility. The composition which should be used as a compromise falls in the range of 9 to 10 per cent Al, because at the higher concentrations of Al, an excess amount of beta is retained thereby affecting ductility and toughness. For aluminum below 9 per cent, the amount of beta appears to be insufficient for successful welding.

The data on mechanical properties (representing the casting in the welded condition, Table 4) and consideration of its ultimate use as a propeller alloy, indicate that the 10 per cent aluminum alloy is optimum with respect to weldability, strength and ductility. A point to be noted is that the tensile strength of the 10 per cent aluminum welded (as-cast) specimen, is at least 75 per cent of the separately cast bar. This is an acceptable percentage in the foundry field, because it is generally recognized that the separately cast test bar properties are not wholly reflected in the casting.

Impurity Content vs. Weldability

It will be noted from Table 5 that wedge block castings containing the "optimum" Al content (approximately 10 per cent) welded satisfactorily despite the fact that Si and Pb were as high as 0.18 and 0.10 per cent, respectively. This emphasizes the previously indicated importance of having the proper level of aluminum. These results were obtained in spite of the fact that radiography revealed a large amount of dross in the as-cast wedge blocks, which was probably due to the use of a previously untried flux.

Fortunately, in the machining of the groove, a major portion of the dross was removed leaving only small amounts in the back-up strip portion of the wedge block casting. It is in this portion that some fine cracks were revealed by dye penetrant inspection which were, however, not due to welding but rather to unsound and drossy metal. The excessive dross in the Si and Pb treated wedge test castings makes it impossible to correlate the effects of these impurity elements on the mechanical properties at this time.

New heats have been cast to provide sample material to check effects of impurity content on mechanical properties. Nevertheless, even though the welding tests were purely qualitative in nature, it is felt that the results tend to show that Pb and Si in the amounts indicated are not injurious to weldability.

The preliminary work,[7] which was the basis of this investigation, was concerned with inconsistent weldability of cast propeller patches with apparently similar chemical compositions. The results of the current investigation tend to confirm and explain facts disclosed by the earlier work. In this connection these points are considered salient:

1) The microstructures which are shown by the preliminary work to be "good" microstructures (high Al content) are similar in appearance to those which are considered weldable on the basis

of results of this investigation. This is evident from a comparison of the microstructure of Fig. 2a (from a reference,[7] and the microstructures for the 9 and 10 per cent Al samples, Fig. 17. Similarly, there is a comparison of nonweldable microstructures (low Al content), Fig. 2c (from a reference[7]) and those for the 6 and 7 per cent Al samples, Fig. 17.

2) Some microstructures of the material studied in the preliminary work, such as Figs. 2b and 2c, show markedly different structures although they apparently have similar chemical compositions. Based upon the current investigation, and especially on the study of microstructures, it is felt that Fig. 2b is more representative of 8 per cent aluminum while Fig. 2c suggests an aluminum content below 8 per cent. Therefore, the value of aluminum given in Table 1 (Item F1) appears to be doubtful, which may be due to the fact that it was obtained by difference. This difficulty was avoided in the current investigation by determining aluminum contents directly.
3) Based upon a limited, qualitative investigation of the effects of silicon and lead contents on weldability, it is felt that these elements, in the percentages as given in the preliminary work were not a cause for cracking.
4) It was felt on the basis of preliminary investigation, that improved weldability would generally be expected to accompany increased elongation due to low Al content. The current work shows that room temperature ductility is not a criterion of resistance to hot shortness at welding temperatures.

CONCLUSIONS

The results of this phase of the investigation on as-cast Ni-Al bronze lead to:

1) The general effect of an increase in aluminum content is to increase strength and hardness and decrease the ductility and toughness.
2) Increasing aluminum content results in a change in microstructure from that consisting primarily of alpha plus kappa to structures containing alpha plus kappa (eutectoid), beta and delta.
3) An aluminum content of approximately 9 to 11 per cent imparts good hot ductility properties necessary for welding. Between 8 and 9 per cent aluminum, there is a transition where enough beta is formed for successful welding.
4) The optimum composition, taking into account weldability, strength, ductility and toughness appears to be at about 9.5 per cent aluminum when the Ni, Fe and Mn were held at 5, 4 and 0.5 per cent, respectively.
5) Elements such as silicon and lead appear to have no effect on the weldability characteristics of the optimum composition in amounts up to 0.18 and 0.10 per cent, respectively.
6) Microstructures can be used as an index to approximate the aluminum content and, hence, the relative weldability.
7) Room temperature ductility is a fair index of toughness properties of the alloy.
8) At high aluminum content levels, where retained beta is prevalent, an increase in hardness is accompanied by a loss in toughness and ductility.
9) Variations in aluminum content of the basic composition in the approximate range of 8.5 to 10 per cent results in virtually no effect on Charpy V-notch properties.
10) For the section sizes (½ to 3½-in. thickness) and temperatures of test (0 to 180 F) studied, Charpy V-notch properties show no significant variations.

ACKNOWLEDGMENT

The authors wish to express their gratitude and appreciation to the bureau of Ships, and particularly Mr. T. J. Griffin, Code 634B, for sponsoring and encouraging the development program which served as the basis for this paper. They are grateful to Captains C. H. Gerlach and I. F. Fike, former and current Directors of the Material Laboratory, respectively, and their staffs for their encouragement in the conduct of the work during their tours of duty. Special acknowledgment is due to Mr. E. A. Imbembo, Head of the Metallurgy Branch for superior general technical guidance during the conduct of the project and for his critical review of the manuscript of the basic report. Mr. J. LoCicero is acknowledged with thanks for having made valuable contributions in conducting the experimental work. Mr. M. C. Laddaga has provided valuable assistance in directing the preparation of heats and sample casting material produced by the Shipyard Foundry for the project.

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SYSTEMATIC APPROACH TO SAND DESIGN AND CONTROL

Progress report 3 — The mulling effect

by G. J. Vingas and A. H. Zrimsek

ABSTRACT

The third in a series of reports presenting basic data describing the effect of a number of variables on foundry sands. This report deals with the effect of mulling time and method of additions to a sand-clay-water system in relation to green compression strength, green shear strength, green tensile strength, ratio of green compression strength to green shear strength, density, dry compression strength and dry shear strength. The clays investigated are western and southern bentonite and fireclay.

INTRODUCTION

The two previous reports of this series, reports one and 2, showed conclusively that mulling must be considered a major variable in sand design and control. It is a major variable to the extent that it often overshadows clay type and clay content in new sand-clay-water systems. In actual foundry practice, however, castings of approximately equal quality are being produced in sands mulled for extensive periods, ones not mulled at all and all points in between. To help clarify the importance of mulling, this separate study on mulling as a major variable was initiated dealing with the effects of mulling on the physical properties of simple sand-clay-water systems.

EXPERIMENT

As in previous reports, the base sand used is that described in the table. In the experiment, bentonite contents of 4.75, 7.45 and 10 per cent and fireclay contents of 10 and 15 per cent were used. Mulling of the various sand-clay-water mixtures was performed in three mullers of the following description:

1. 12 in. diameter laboratory muller with 1500 gram capacity, 46 rpm, 2 — 6 in. diameter x 1½-in. width wheels. Batch size for this experiment — 1250 grams.
2. 18 in. diameter laboratory muller with 5000 gram capacity, 40 rpm, 2 — 9 in. diameter x 2½-in. width wheels. Batch size for this experiment — 4500 grams.
3. 40 in. diameter production muller with 200 lb capacity, 48 rpm, 2 — 16 in. diameter x 3-in. width wheels. Batch size for this experiment — 150 lb.

Two methods of addition were employed in the experiment. In the first, sand and clay were dry mulled for 15 sec, after which water was added and the mixture wet mulled for periods of 2, 4, 6 or 12 min. In the second method, water was added to sand and distributed by a 15 sec mull, after which clay addition was made and mulling continued for 2, 4, 6 or 12 min periods.

With the variation in mullers, mulling time, clay content and type, methods of addition and water content, a total of 200 different mixtures were produced in the experiment for study.

The sands produced were discharged into airtight polyethylene bags and tested immediately for green compression, green shear and tensile strengths as well as rammed density at 1, 3, 5, 7 and 10 rams. Specimens for dry compression and dry shear were prepared at the same ramming energies and oven dried at 220-230 F for not less than 5 hr.

SCREEN ANALYSIS OF BASE SAND USED

U.S. Standard Sieve No.	Retained, %
20	0.0
30	2.6
40	19.3
50	30.1
70	24.4
100	15.1
140	5.6
200	2.4
Pan	0.6

RESULTS

The results of the experiment are summarized graphically in Figs. 1 through 16. As in previous reports, graphical representation of data is employed. The large volume of data collected prohibits presentation in tabular form. Graphical presentation also illustrates more clearly the principles involved.

DISCUSSION

Literature dealing with foundry sands seldom includes consideration of mulling as a major variable. Mulling is referred to simply as adequate, implying

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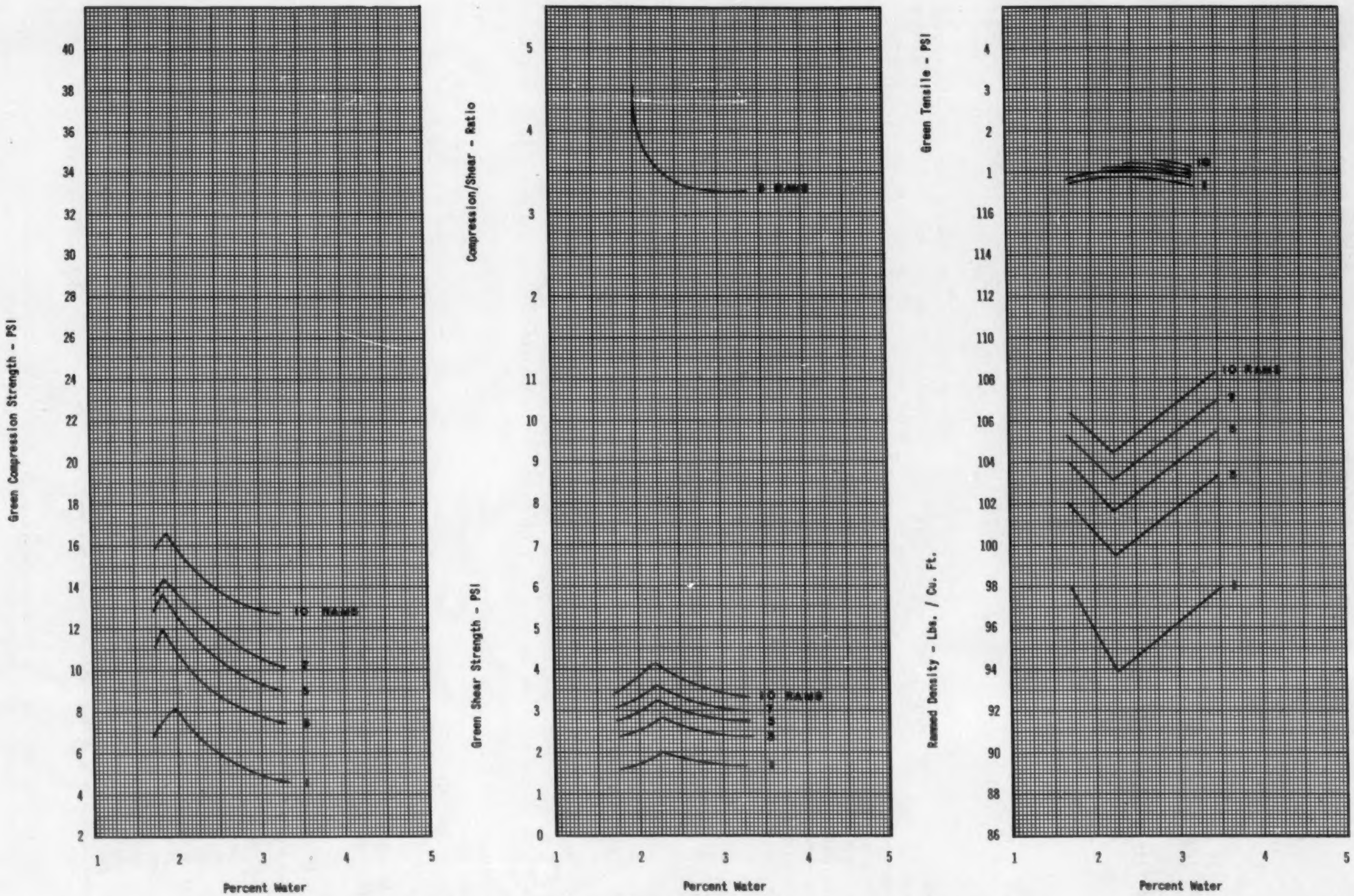

Fig. 1 — Water content and ramming energy effect on physical properties of 4.75 per cent western bentonite bonded Portage silica sand mulled 4 min. Method of addition: clay followed by water.

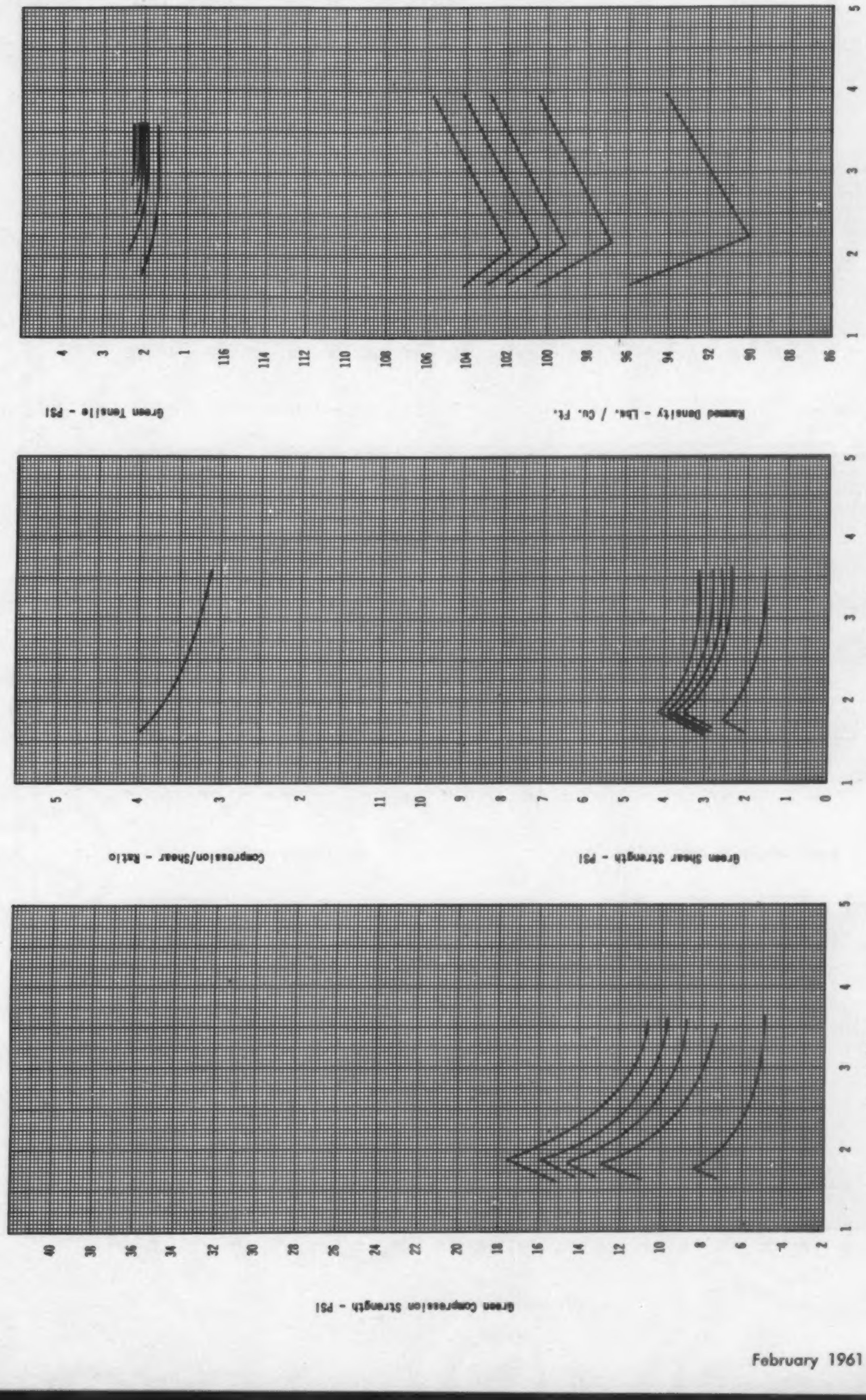

Fig. 2 — Water content and ramming energy effect on physical properties of 4.75 per cent western bentonite bonded Portage silica sand mulled 6 min. Method of addition: clay followed by water.

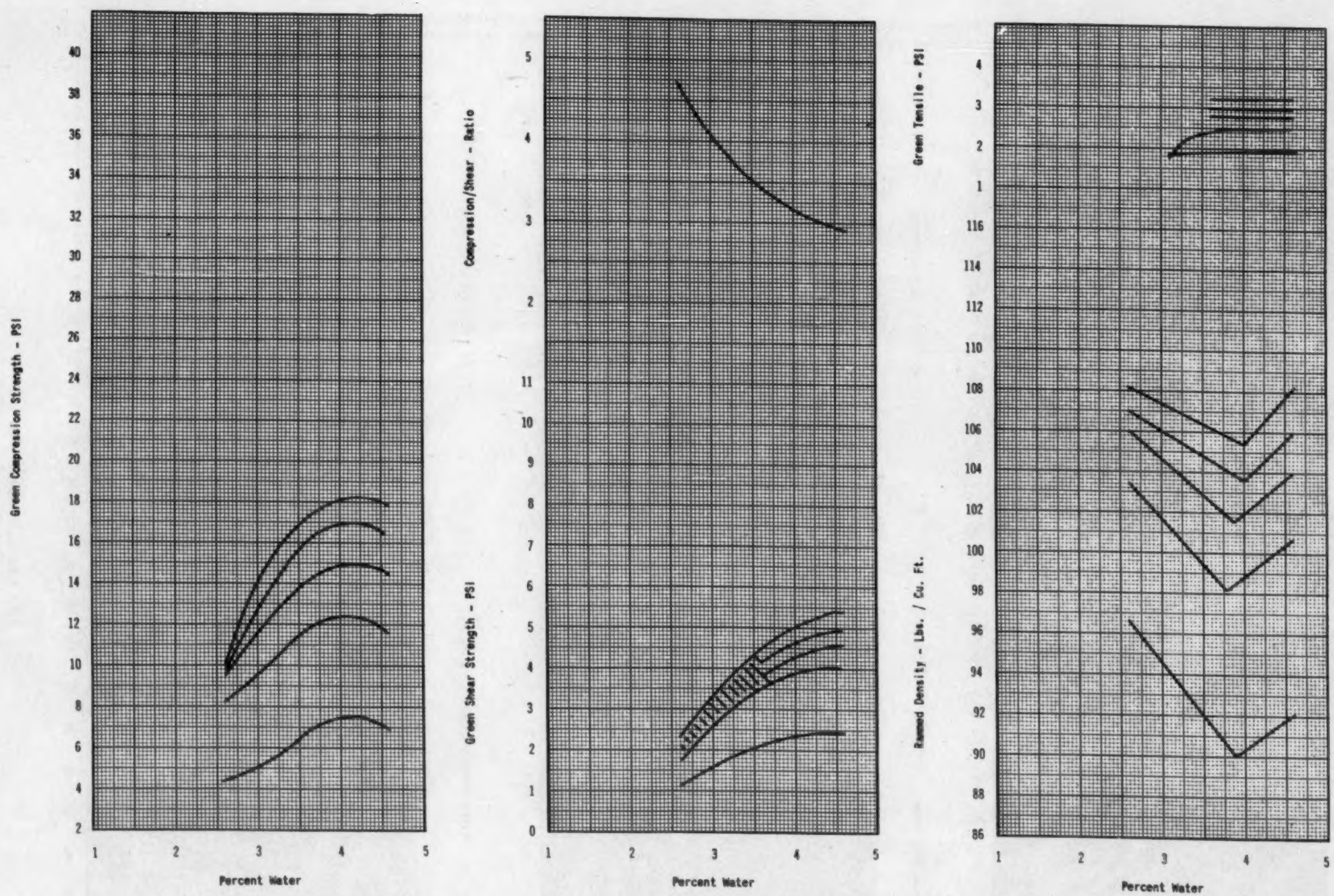

Fig. 3 — Water content and ramming energy effect on physical properties of 7.45 per cent western bentonite bonded Portage silica sand mulled 2 min. Method of addition: clay followed by water.

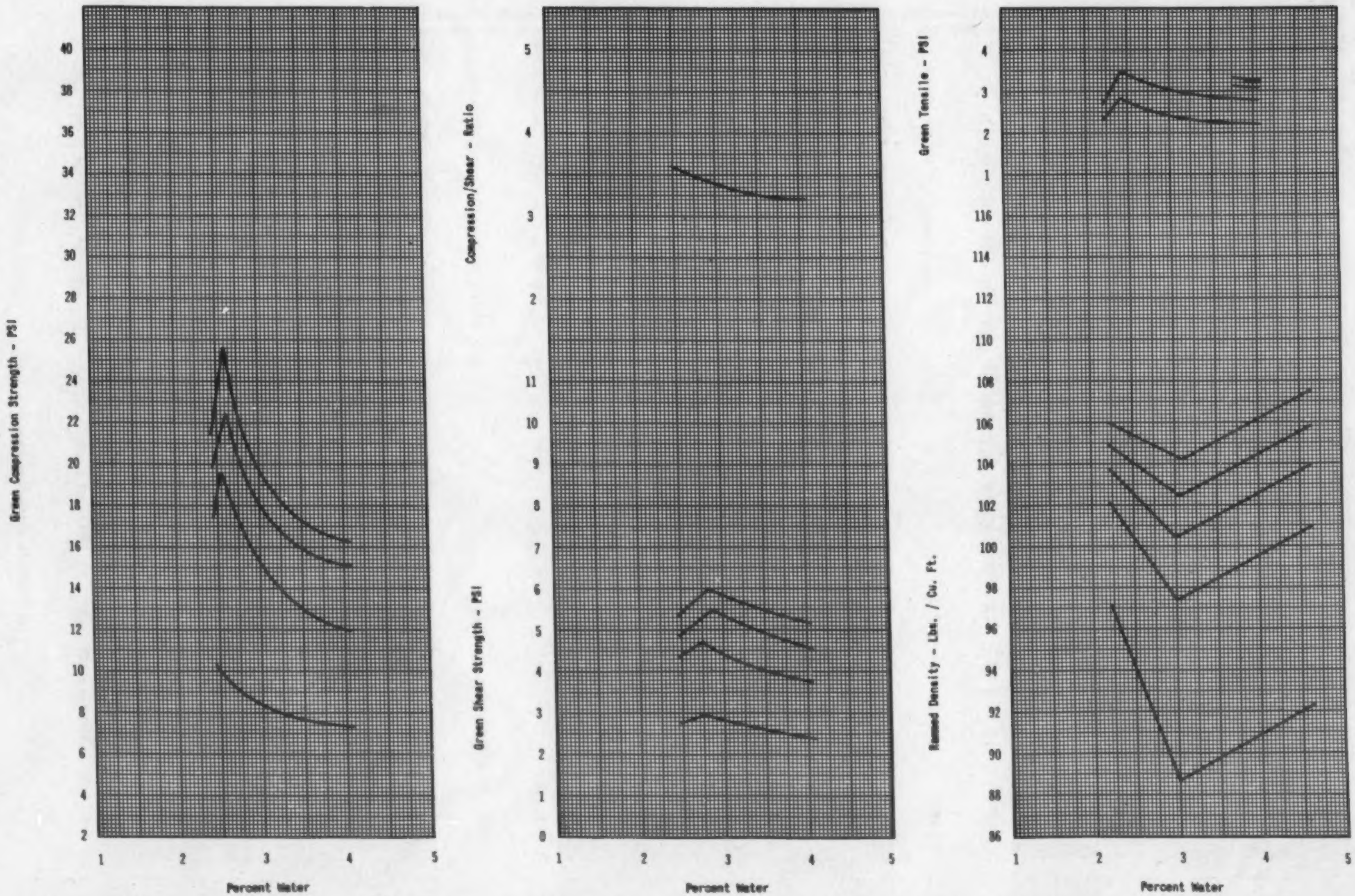

Fig. 4 — Water content and ramming energy effect on physical properties of 7.45 per cent western bentonite bonded Portage silica sand mulled 6 min. Method of addition: clay followed by water.

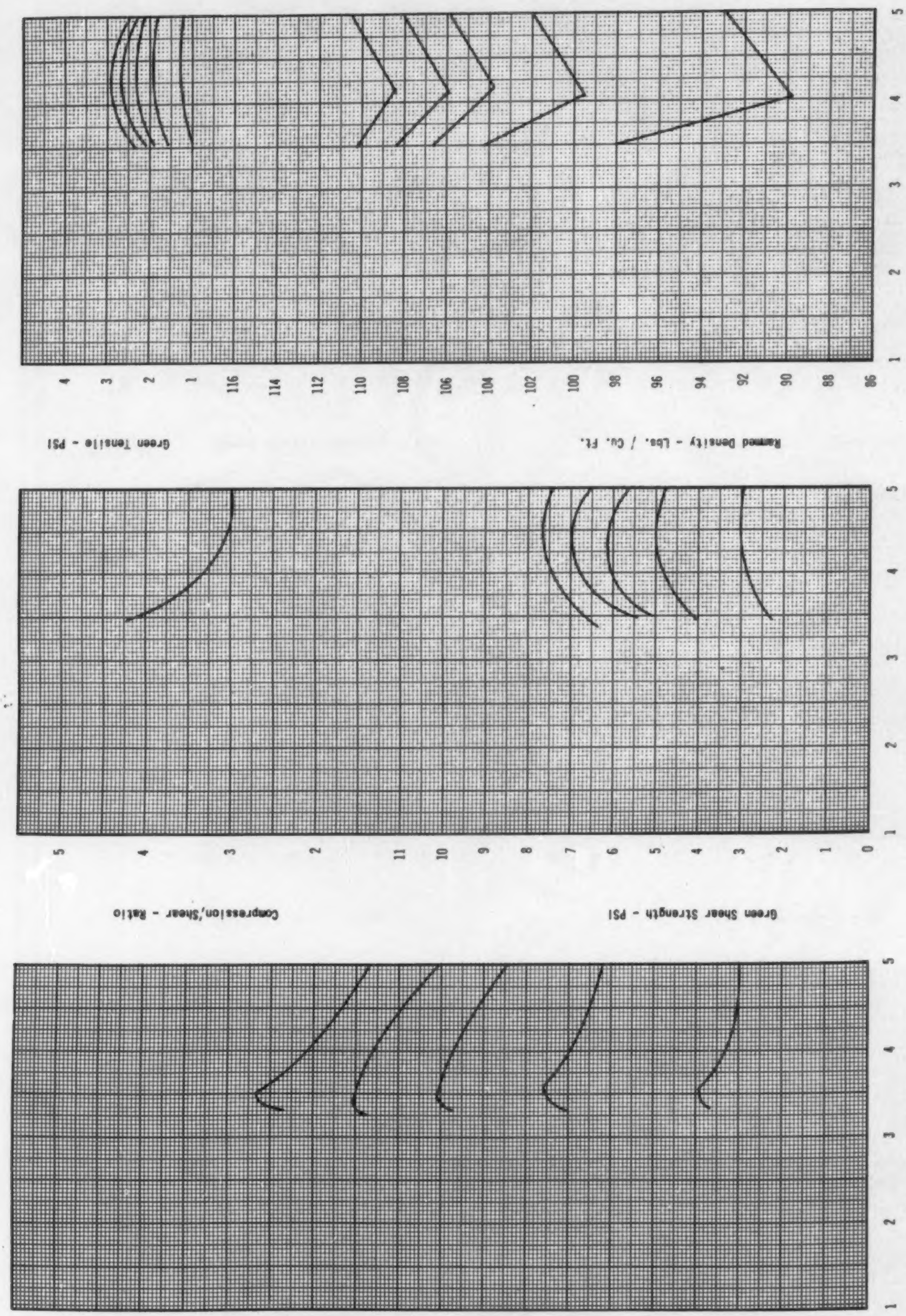

Fig. 5 — Water content and ramming energy effect on physical properties of 10 per cent western bentonite bonded Portage silica sand mulled 4 min. Method of addition: clay followed by water.

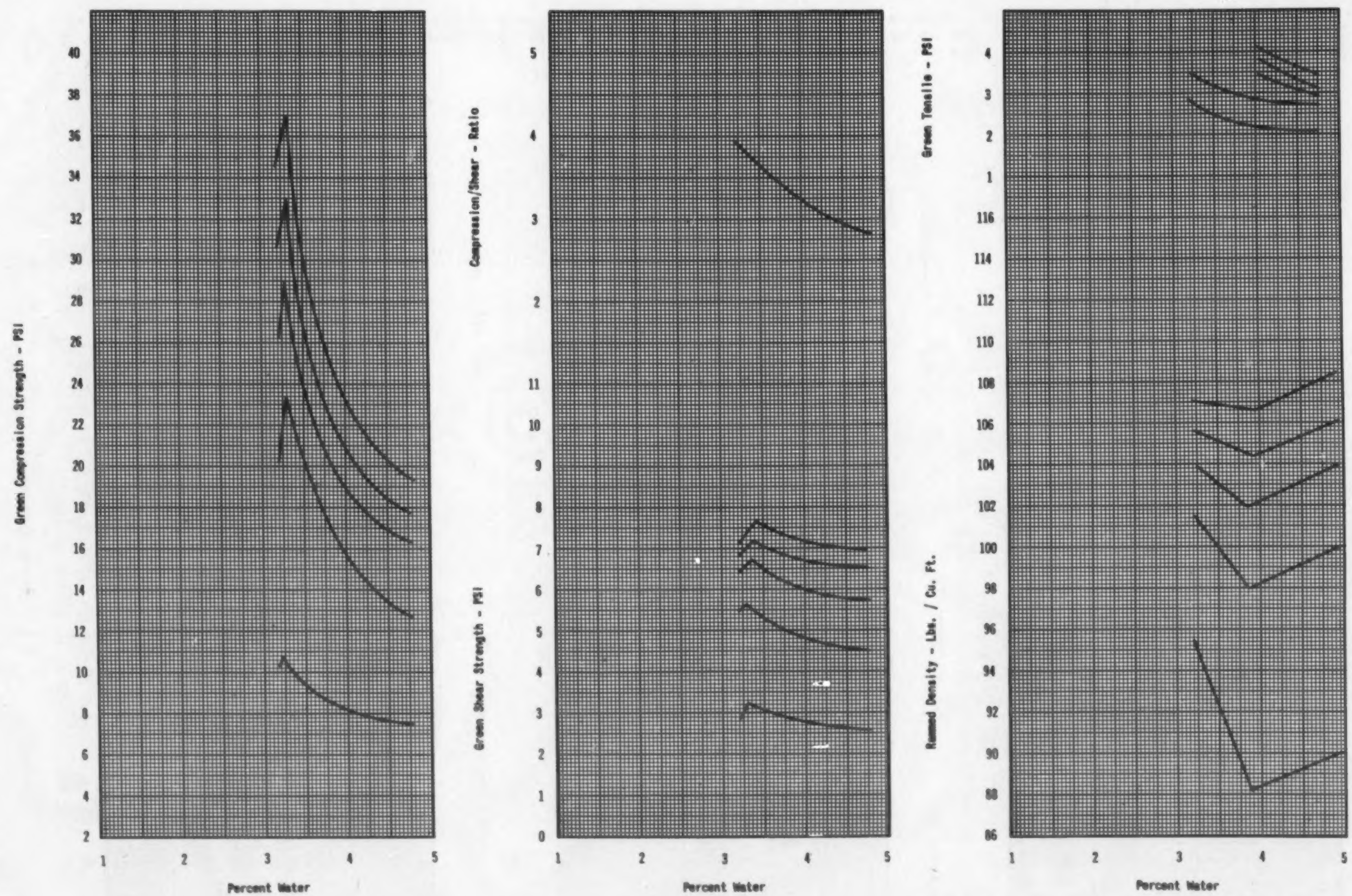

Fig. 6 — Water content and ramming energy effect on physical properties of 10 per cent western bentonite bonded Portage silica sand mulled 6 min. Method of addition: clay followed by water.

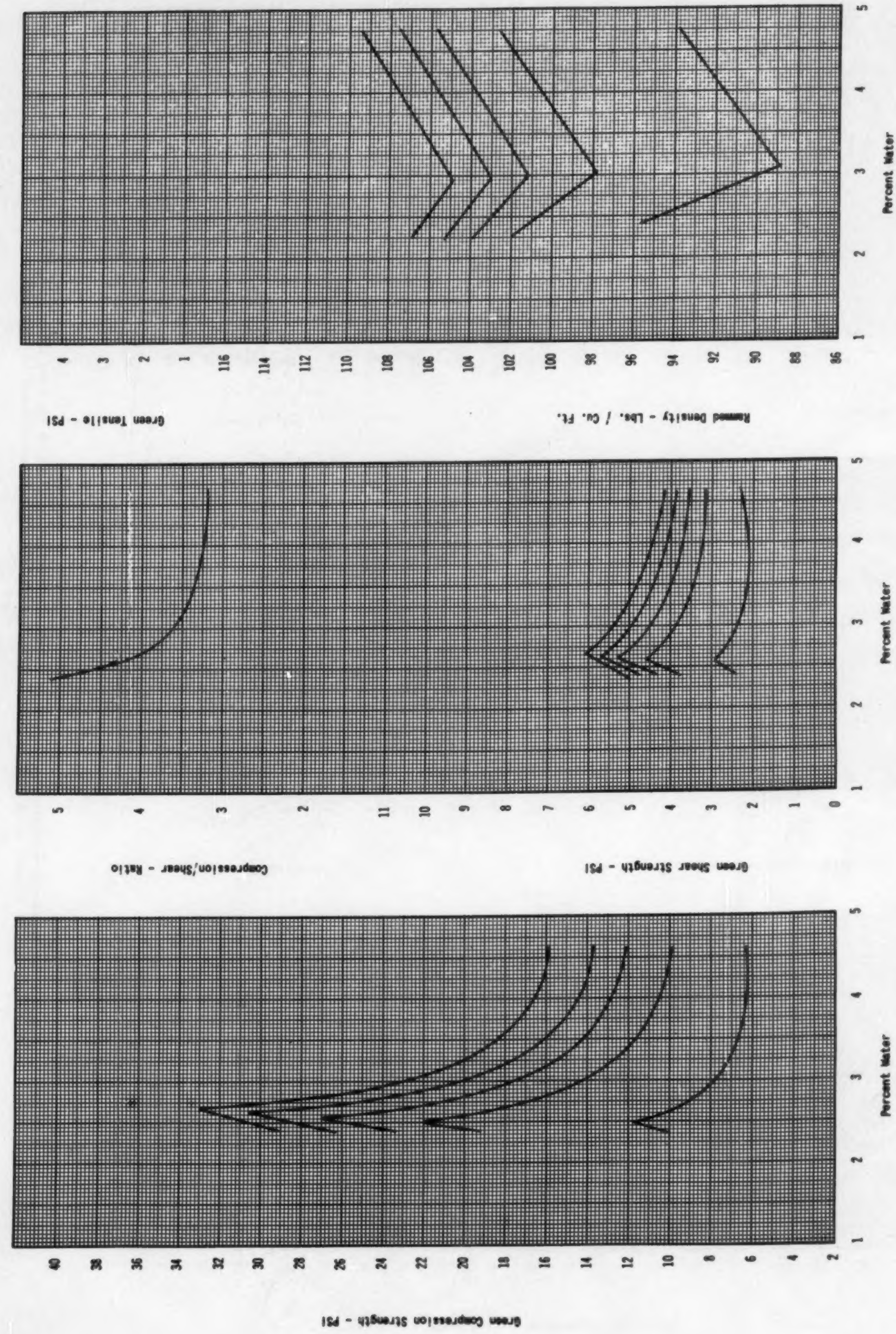

Fig. 7 — Water content and ramming energy effect on physical properties of 7.45 per cent western bentonite bonded Portage silica sand mulled 6 min. Method of addition: water followed by clay.

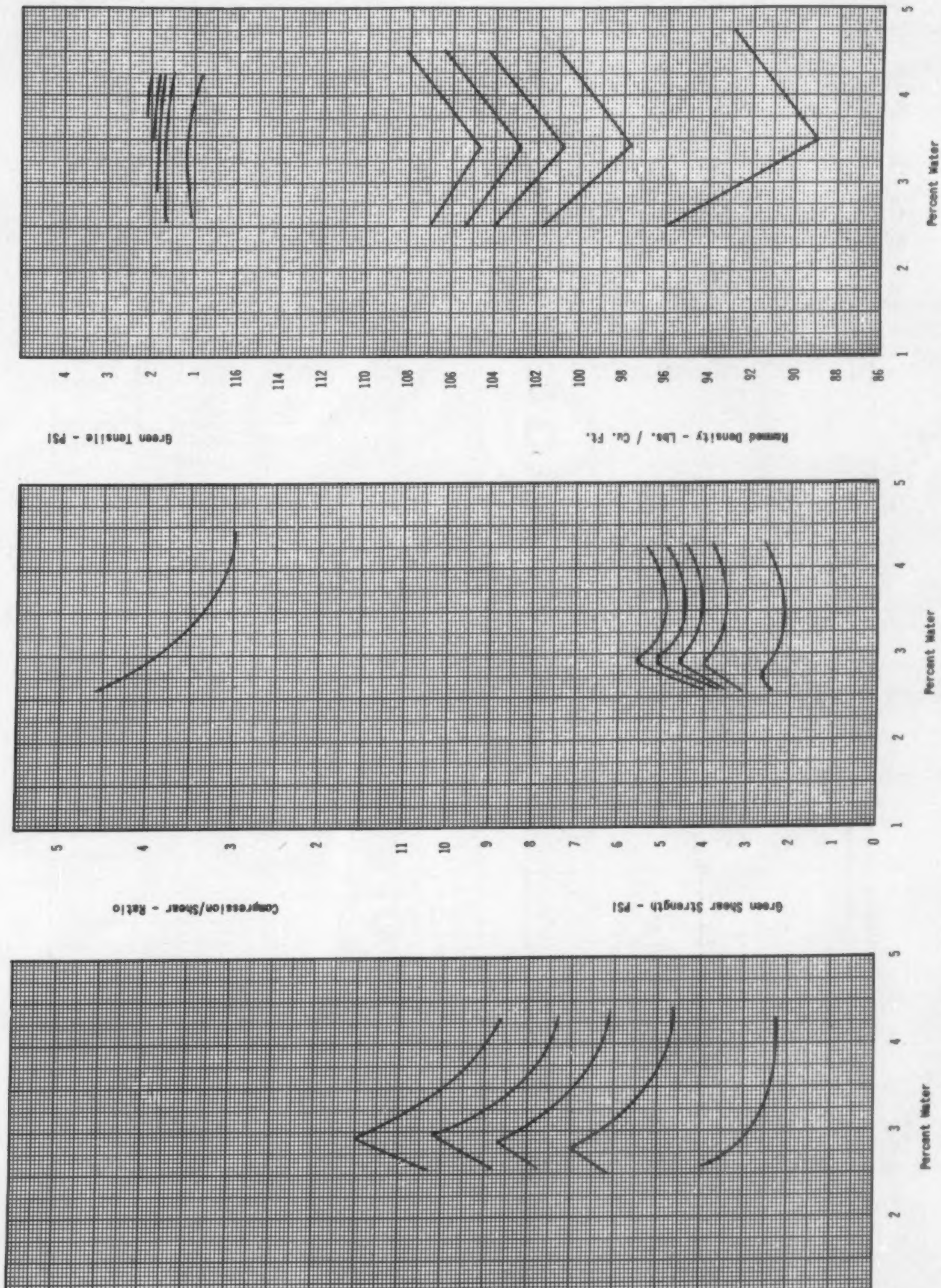

Fig. 8 — Water content and ramming energy effect on physical properties of 7.45 per cent western bentonite bonded Portage silica sand mulled 2 min. Method of addition: water followed by clay.

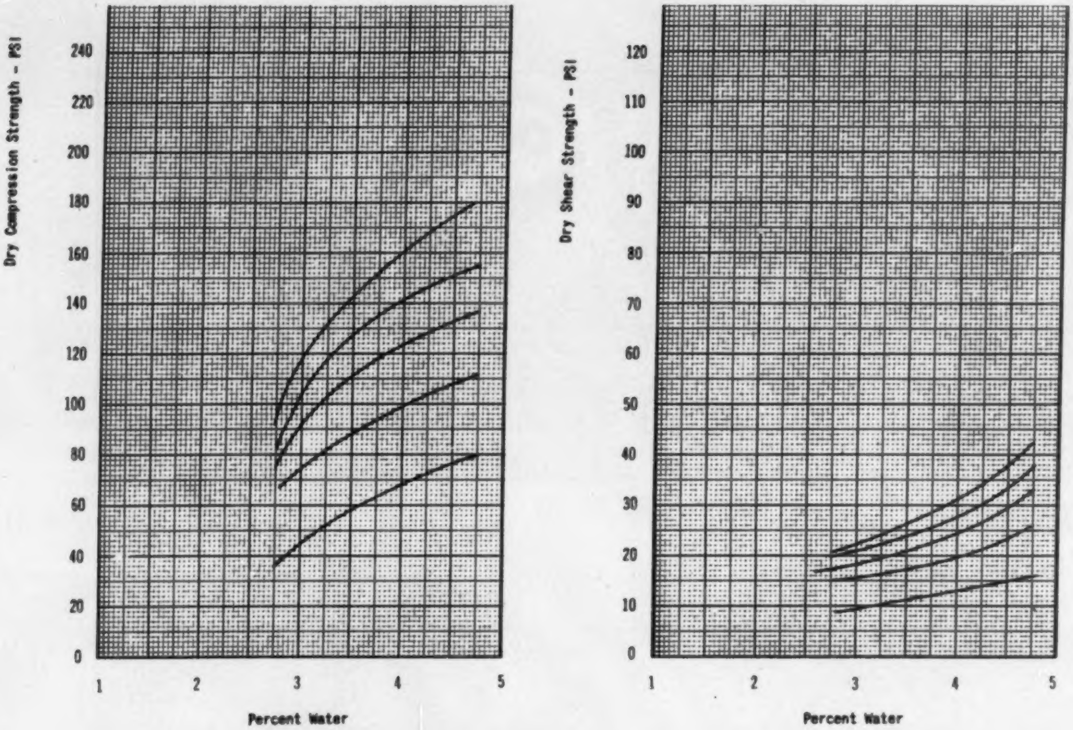

Fig. 9 — Water content and ramming energy effect on physical properties of 7.45 per cent southern bentonite bonded Portage silica sand mulled 4 min. Method of addition: water followed by clay.

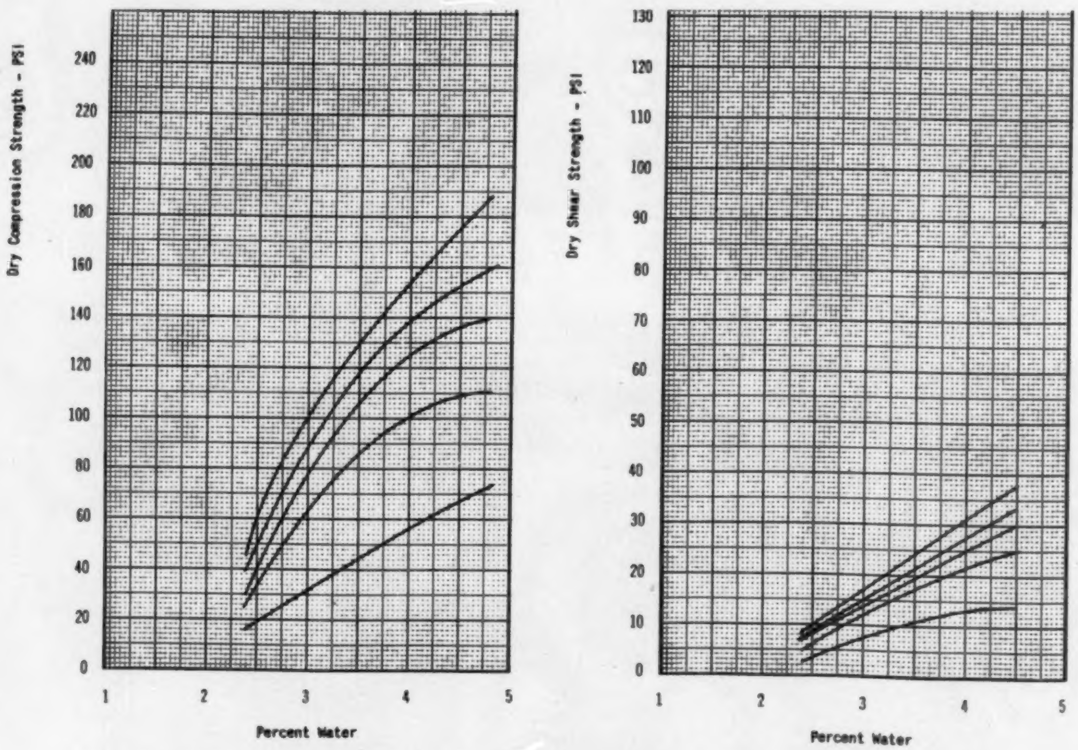

Fig. 10 — Water content and ramming energy effect on physical properties of 7.45 per cent southern bentonite bonded Portage silica sand mulled 2 min. Method of addition: water followed by clay.

that it is long or complete, with the assumption that extensive mulling is good mulling. This progress report will show that mulling is relative, that there is no absolute and that equipment as well as clay per cent, clay type and water content are variables which must be considered.

Previous reports have shown the influence of mulling time on the physical properties of sand-clay-water systems. In general, as the water content of the sand mixture is increased, the effects of varied mulling decrease. At the higher water contents, it is actually possible for overmulling to occur, and sands can actually experience a drop in green and dry properties.

It was also noted that western bentonite sands were influenced to a considerably greater extent by variations in mulling than were fireclay and southern bentonite sands, in that order.

Since western bentonite bonded sands are affected by mulling variation to a greater degree than either fireclay or southern bentonite sands, the majority of data to be covered will deal with western bentonite sands.

Green Strength Development

A thorough study of Figs. 1 through 6 shows that as western bentonite content is increased the mulling time required for development of maximum green

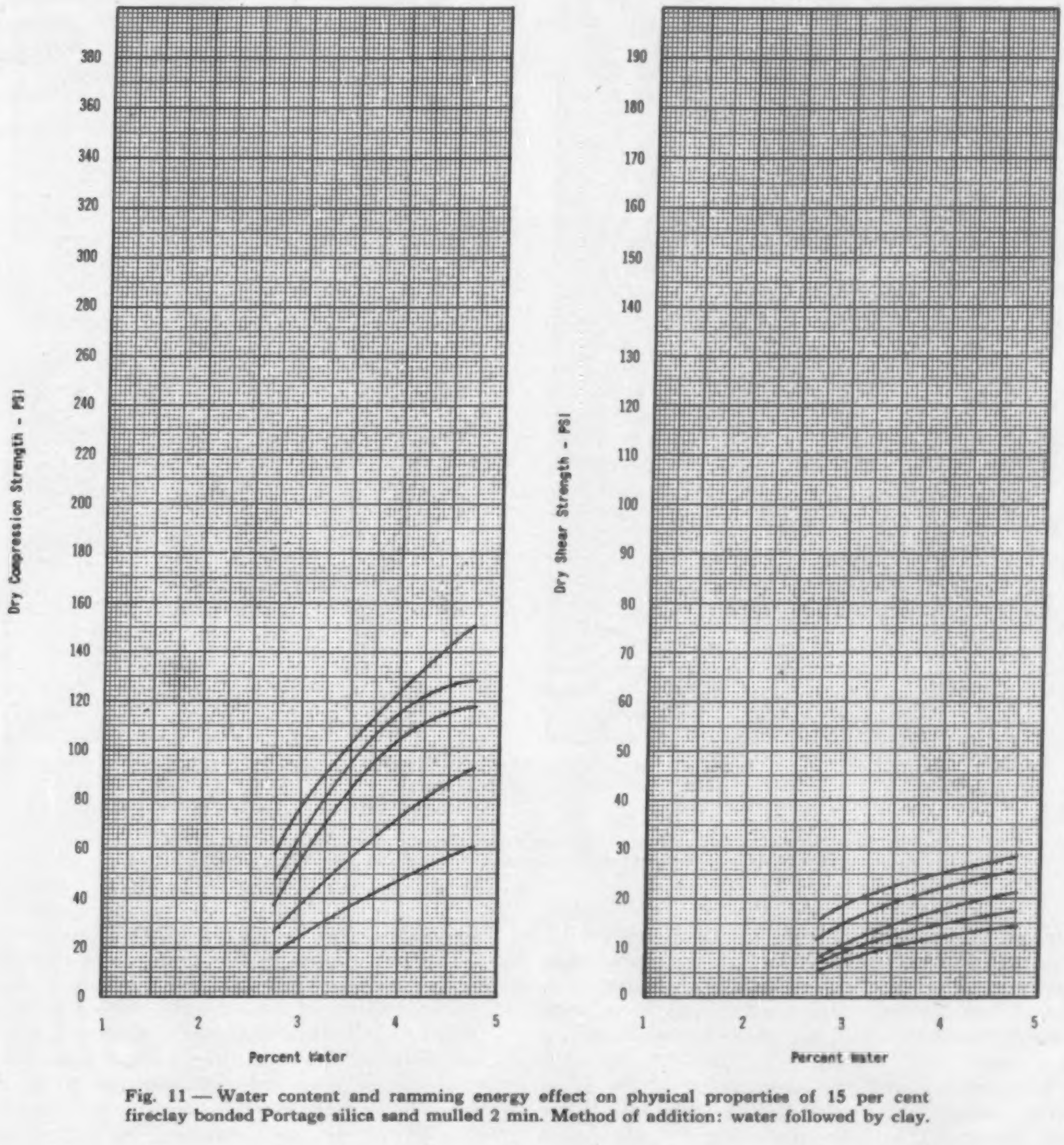

Fig. 11 — Water content and ramming energy effect on physical properties of 15 per cent fireclay bonded Portage silica sand mulled 2 min. Method of addition: water followed by clay.

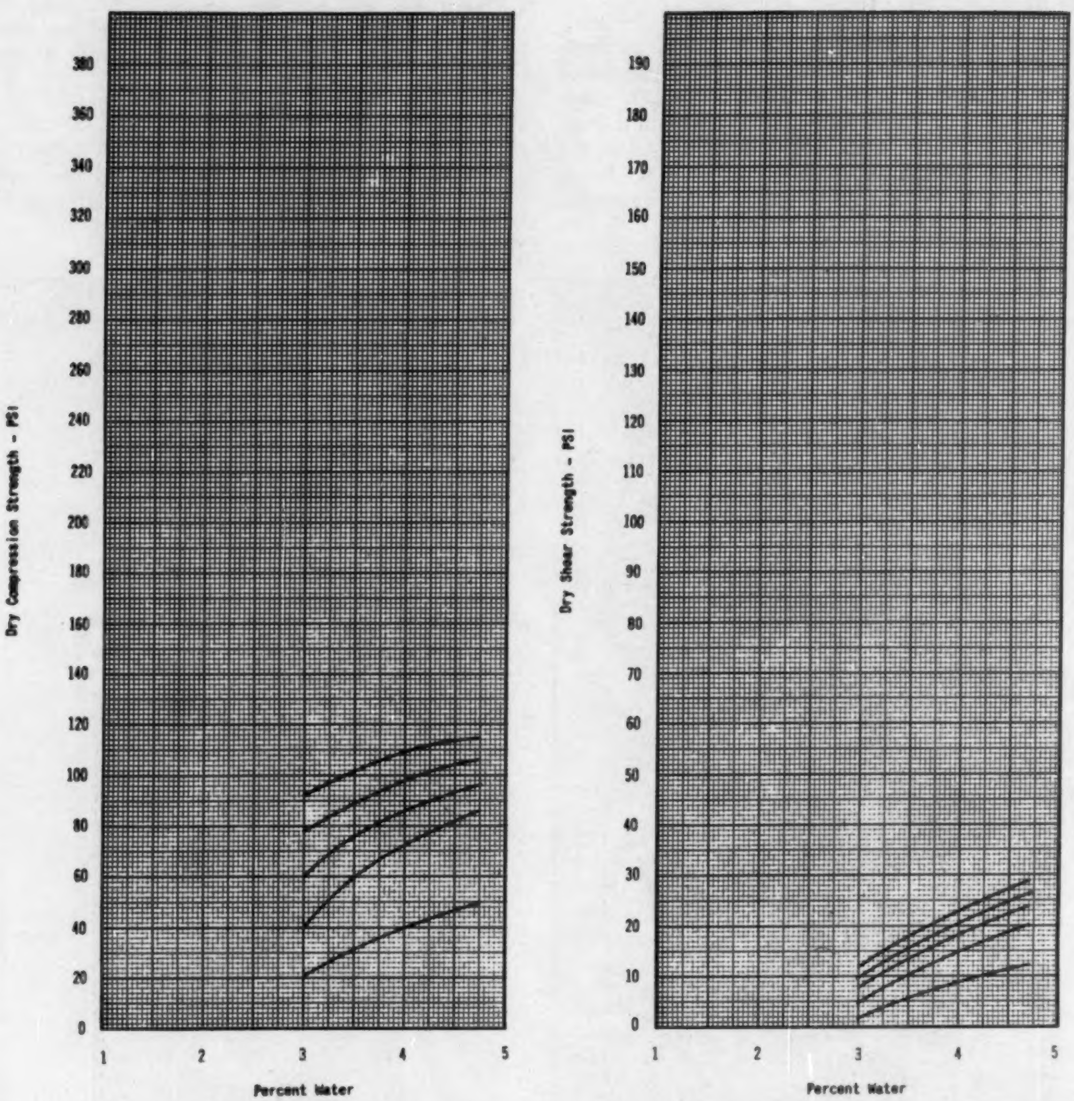

Fig. 12 — Water content and ramming energy effect on physical properties of 15 per cent fireclay bonded Portage silica sand mulled 6 min. Method of addition: water followed by clay.

strength at water contents near peak strength is increased. The system bonded with 4.75 per cent western has come close to reaching its full potential with only 4 min mulling, while the 7.45 and 10 per cent western bentonite sands are somewhat undermulled at 4 min.

Data dealing with the development of dry properties, though not presented here, substantiate the conclusion that mulling requirements increase with increasing clay content. It is also apparent that at high water levels the clay content becomes a minor factor, and that at all clay levels green compression actually dropped with extensive mulling.

A comparison of Figs. 3 and 4 with Figs. 7 and 8 illustrates the effect of reversing the method of clay and water additions. Figures 3 and 4 show that development of physical properties is slow for sands prepared by adding water to a mixture of sand and clay. In contrast, sands prepared by adding clay to pre-wetted sand develop much faster, as can be seen

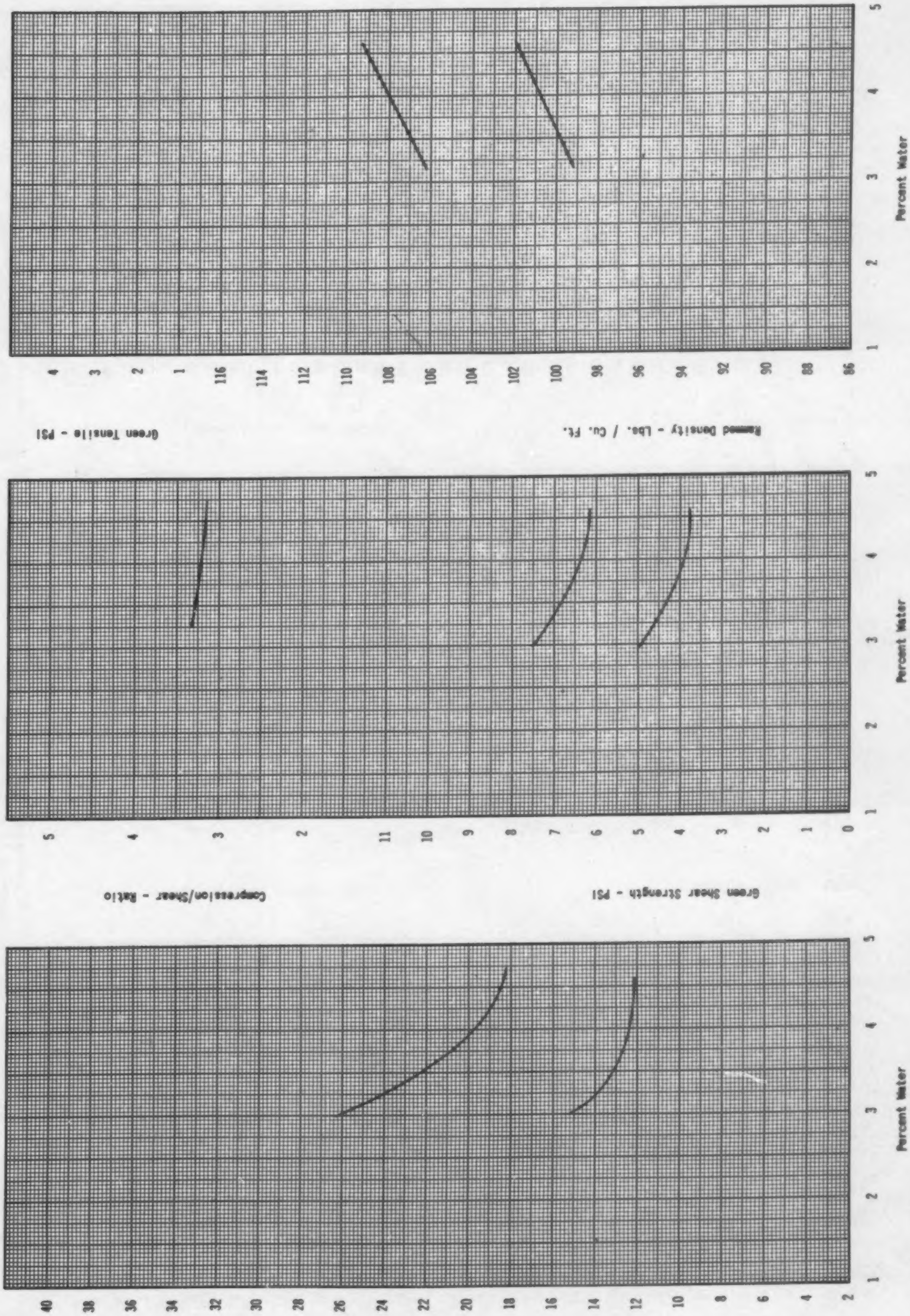

Fig. 13 — Water content and ramming energy effect on physical properties of 7.45 per cent western bentonite bonded Portage silica sand mulled 2 min in muller with 12 in. diameter. Method of addition: clay followed by water.

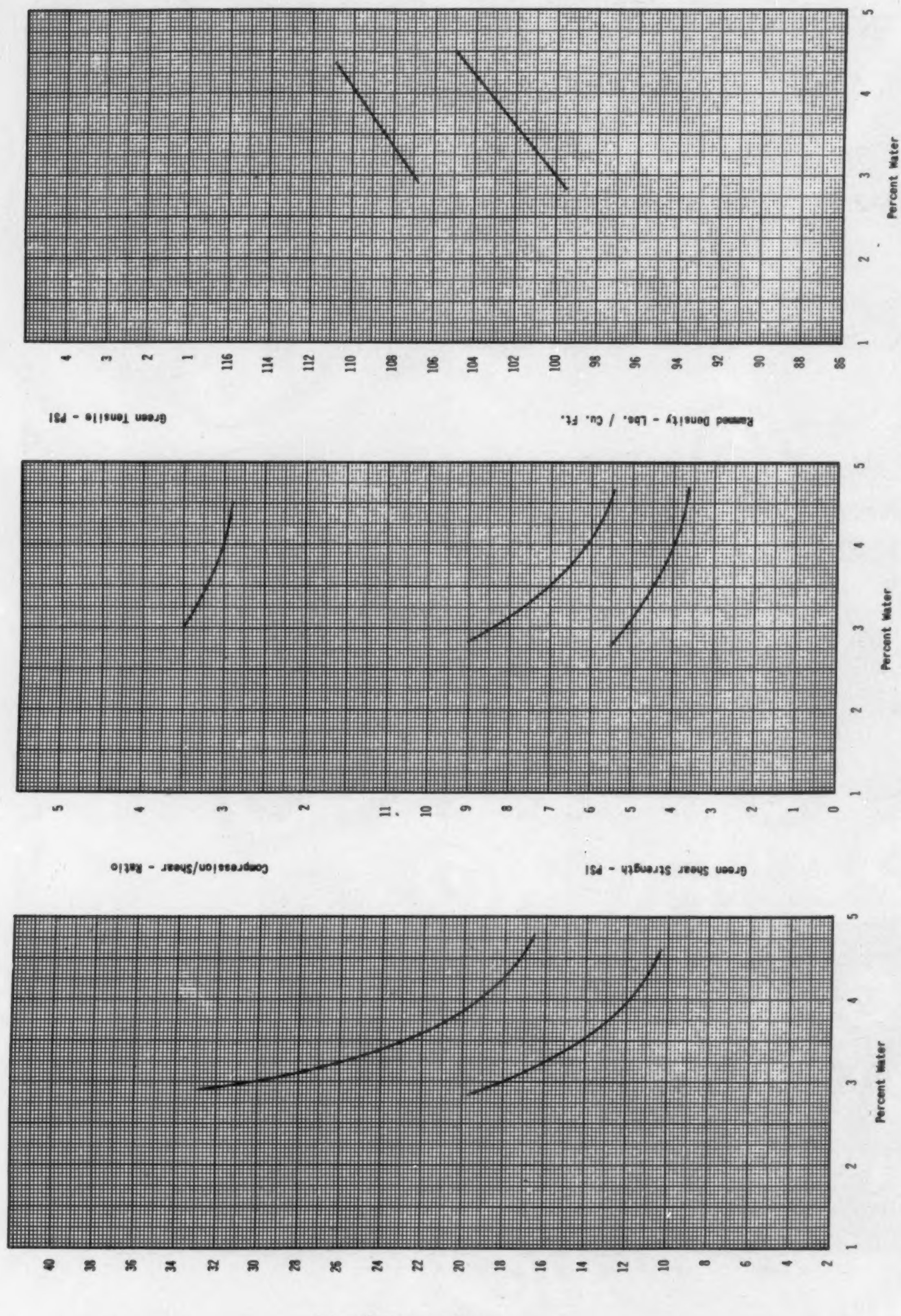

Fig. 14 — Water content and ramming energy effect on physical properties of 7.45 per cent western bentonite bonded Portage silica sand mulled 6 min in muller with 12 in. diameter. Method of addition: clay followed by water.

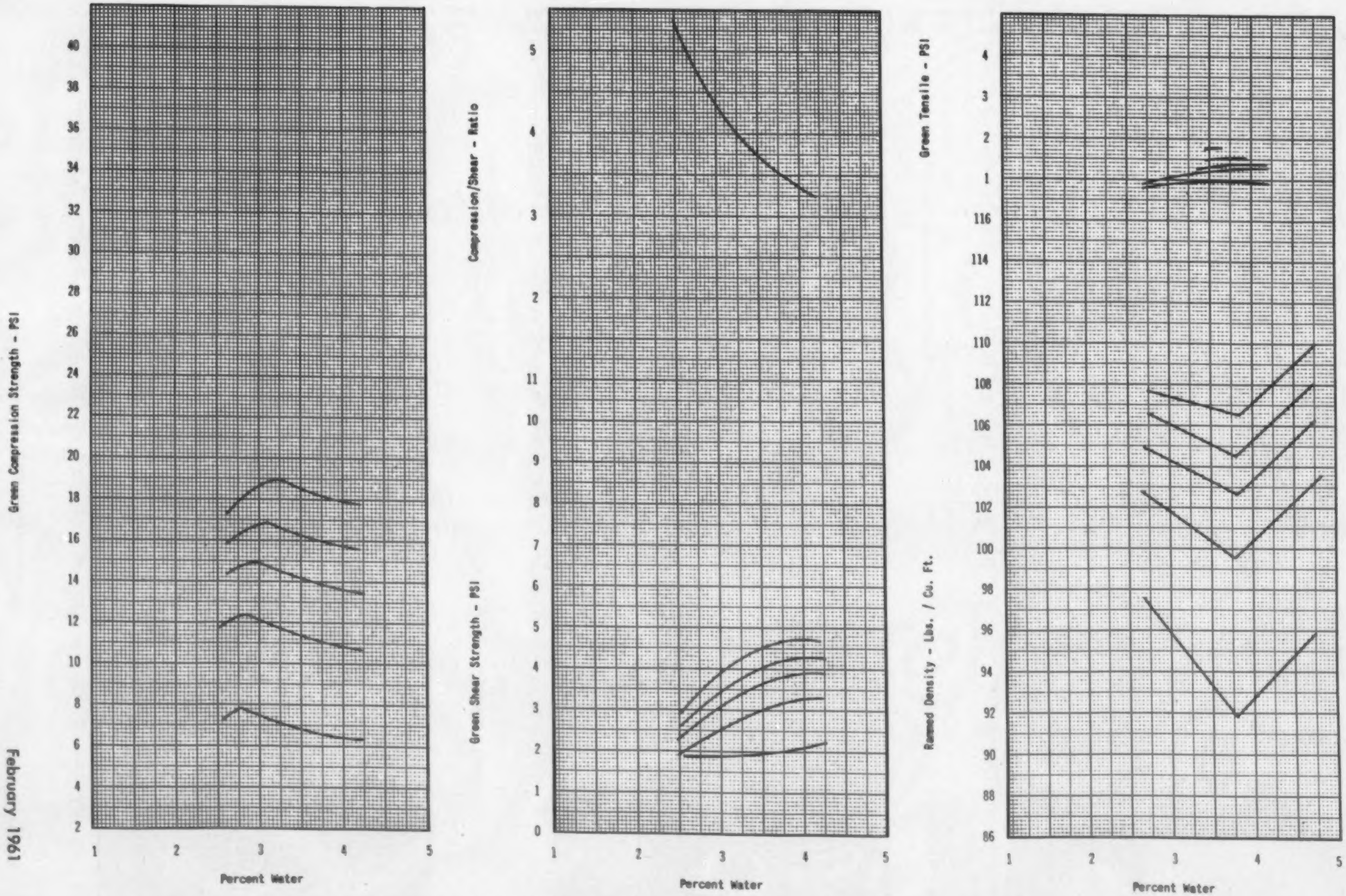

Fig. 15 — Water content and ramming energy effect on physical properties of 7.45 per cent western bentonite bonded Portage silica sand mulled 2 min in muller with 40 in. diameter. Method of addition: clay followed by water.

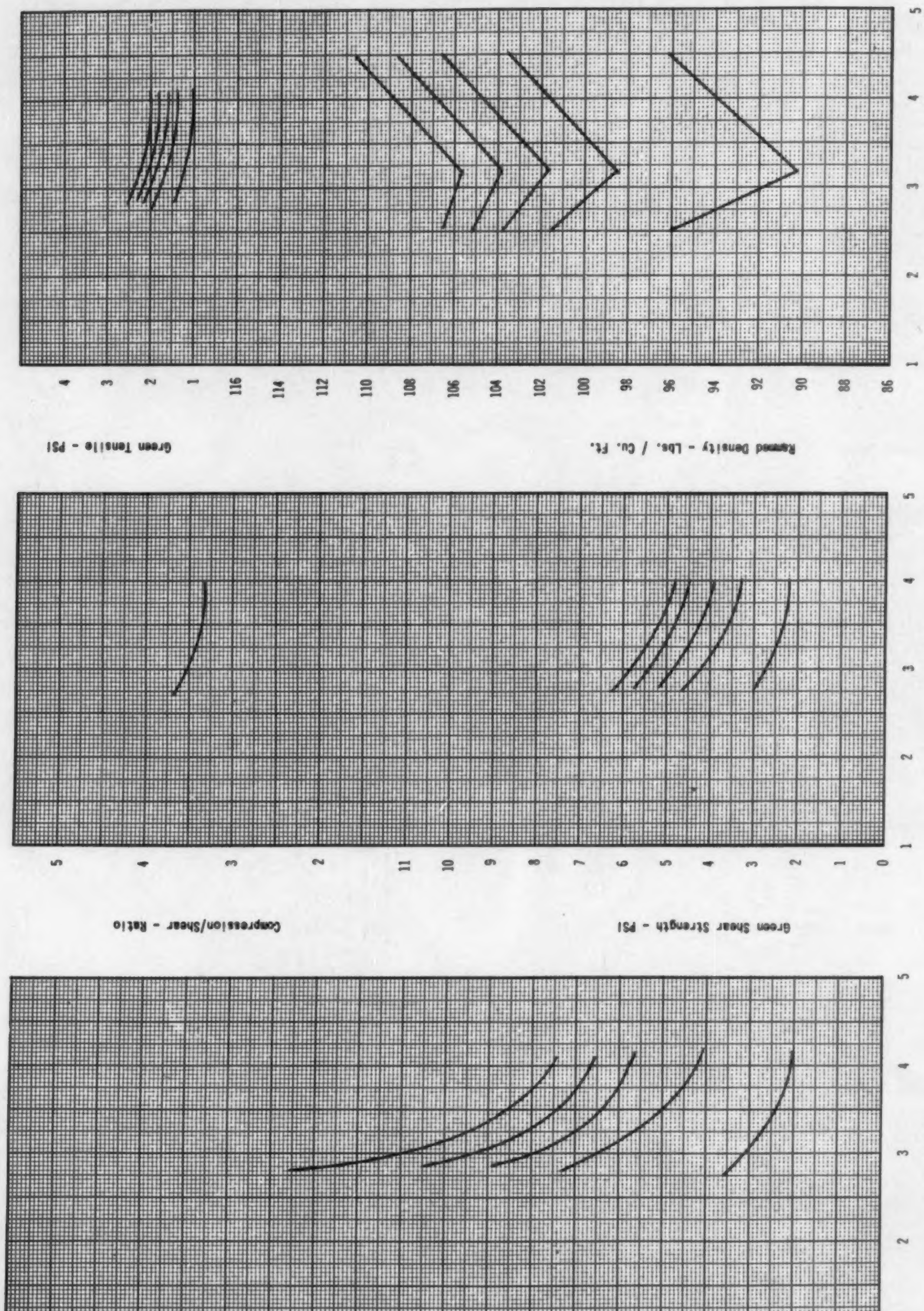

Fig. 16 — Water content and ramming energy effect on physical properties of 7.45 per cent western bentonite bonded Portage silica sand mulled 6 min in muller with 40 in. diameter. Method of addition: clay followed by water.

in Figs. 7 and 8. This method of additions allowed development of properties in only 2 min mulling, which were not too far removed from those obtained with 6 min mulling when water is added to sand-clay mixtures.

It can also be seen by comparing Figs. 4 and 8 that the mulling efficiency at 6 min mulling is substantially greater when water additions preceed clay ones. At high water contents, however, the effects of overmulling become more apparent through use of the water-first method. Although green properties dropped with improved mulling at high water levels, dry strengths continued to rise as mulling efficiency improved.

Southern bentonite and fireclay bonded sands reacted quite differently to changes in the method of addition. Southern bentonite and fireclay sands develop green properties quite readily regardless of the method of addition, the water-first method being slightly superior. These southern and fireclay sands experienced a drop in green as well as dry properties with increased mulling time. The use of the water-first method of additions also resulted in a substantial drop in dry strength. The cause of what appears to be overmulling is not understood at this time. The only comment which can be made is that it does occur.

Method of Addition Effect

There can be no doubt that the method of addition has important bearing on the mulling characteristics and final physical properties of clay bonded sands. To further assess the importance of mulling as a variable, three mullers, as described in the experiment section of this report, were used to prepare sands for evaluation of mulling characteristics and potential.

To accentuate the differences in mullers, the 7.45 per cent western bentonite-sand-water system, with water additions following clay additions, was used. As expected, the data collected showed that both the muller characteristics and potential of the three mullers are different. In comparing Figs. 3 and 4 with Figs. 13 through 16, it becomes apparent that the 12 in. diameter laboratory muller not only develops physical properties more rapidly, but the potential at 6 min mulling is also greater than the 18 in. diameter muller.

The 40 in. diameter muller developed higher physicals much earlier in the mulling cycle, but its potential at 6 min mulling is not much different than the 18 in. muller. As previously mentioned, green properties actually dropped with increased mulling time or efficiency at high water levels. As a consequence, sands containing high water that were mulled in the 12 in. muller for 6 min had the lowest strength, and in keeping with the observations made earlier relative to dry properties, had the highest dry properties.

The 3-ram dry compression at 4.3 per cent water was 190 psi, substantially higher than the 152 psi obtained with both the 18 and 40 in. mullers. This also seems to confirm the popular opinion that the dry strength potential of western is higher than that of southern bentonite. It will be recalled that the bulk of data from earlier reports indicated that the dry strength potential of western and southern was equal. This again emphasizes the importance of mulling as a major variable. When we consider that the three mullers studied are essentially the same type, it is not illogical to expect even greater differences if the study were extended to other type mullers.

Data Application

Application of the principles described by the data of this report can aid the foundryman in choosing the most economical combination of mulling equipment, clay type and content and working water range. While efficient mulling equipment would give greater flexibility, the data clearly show that through the application of principles, sands of adequate quality can be produced by low efficiency mixers and cutters.

Where mixers or cutters are employed, adequate physicals can be consistently obtained by employing high clay and high water levels. Consistent results cannot be obtained with this type equipment when low water levels are employed, nor can adequate physicals be obtained except through use of high clay content.

The more efficient mullers, on the other hand, possess a high degree of flexibility. Through a combination of low clay, low water and long mulling, sands of medium physicals can be obtained. High physicals can be attained through use of high clay, low water, and long mulling. Where facilities are overtaxed, large volumes of sand can be produced through short mulling cycles and a combination of high clay and water levels.

The data clearly show that it is not possible to produce sands of consistent quality at low water levels when low mulling efficiency is employed. Since high strength is obtained only at lower water, it is not possible to obtain consistent sands of high strength except through efficient mulling. There is sufficient difference in the mulling characteristics of western bentonite, southern bentonite and fireclay to indicate that the choice of clay to be used can depend on the prevailing mulling conditions.

CONCLUSIONS

Dry sands are influenced by mulling to a greater extent than wet sands. Mulling efficiency decreases with increased clay at low water contents.

Western bentonite sands respond to mulling at a slower rate than fireclay and southern bentonite sands, in that order.

At high water levels, sands bonded with any of the three clay types experience a drop in green physical with extended mulling. Fireclay and southern bentonite sands also experience a drop in dry physicals.

Addition of water to sand followed by clay rather than clay addition followed by water is the more efficient method of additions.

There is a significant difference in the mulling performance of various mullers.

ACKNOWLEDGMENT

The writers wish to express their appreciation for permission of Magnet Cove Barium Corp. to gather and evaluate the data for this series of progress reports and publish the findings in written form.

AIRCRAFT – MISSILE STEEL CASTINGS

Challenge or compromise

by S. A. McCarthy

ABSTRACT

During the past and present years of jet aircraft and missile progress foundrymen have become more and more adept in the knowledge to the needs, as well as the rewards, of working directly with the design engineers in creating steel castings to meet the requirements of the producer and consumer. The intention of this mutual objective is that steel casting design must make efficient use of the practical metals and alloy compositions to result in good castability in the foundry. The system of good steel casting designs must be a satisfactory engineering approach to obtain these two desired end products — 1) good castability characteristics and 2) equal stress distribution while in application.

INTRODUCTION

Foundrymen and design engineers of steel castings are aware that each has basically similar problems in castings, either of commercial or aircraft quality application. However, there must be a separation in the preliminary planning of the design which will produce the best possible casting at the lowest possible cost. This division must be understood–that aircraft and missile steel castings are not processed through the foundry in the same "tote" boxes, but approached on an individual basis other than for commercial or mechanical requirements. This is the result of the high standards demanded by the military services that are mandatory in the production of precision quality castings for high performance aircraft application.

DESIGN COORDINATION

When developing successful designs to be processed as precision steel castings, assurance of the serviceability must be focused on engineering material that is dependent on quality and adequate laboratory and field testing information, if satisfactory production is ultimately to be achieved. These principles imposed are generally located in foundry practice to involve adjustment, rather than radical changes in intended design. Every steel casting design undertaken for aircraft or missile application forms a challenge or compromise. The challenge usually attempts to obtain tolerance ranges in the as-cast condition to eliminate additional costly major or minor machining requirements. The compromise may include several concessions:

1) Some dimensioning may indicate excess metal to permit machining for closer inside limits than possible economically in the as-cast condition.
2) Complex or intricate cored areas or holes be solid metal where a high degree of close tolerance accuracy of center locations is required that would necessitate end mill or reaming operations be overly difficult.
3) Design modification to be of assistance to the foundry and facilitate the desirable aspects for elimination of added machining.

A great percentage of aircraft steel casting designs submitted are often referred to as "tool room" drawings, when dimensional tolerances indicated are less than $\pm$ 0.03 in. and draft angles two degrees maximum, with wall or sectional thickness less than 0.25 in. over all. Precision quality steel castings are the result of coordinated evaluation previous to final acceptance that includes stress analysis, material, weight, cost and procurement time.

When these factors are favorable, the design is released for production, and firm costs are sought by sealed bid quotation from three or more approved casting sources. Upon return of the quotation with the marked up "redline" print to Engineering, a complete re-evaluation is made of the requested concessions by the casting facility. This may involve changes in dimensional tolerances, radius, fillets, alloy preferences, etc. If affirmative or negative, the incorporated requests are made on the drawing to be released as acceptable for the design of the casting by the successful bidding facility.

PRODUCTION CONCESSIONS

Occasionally it becomes necessary to deviate from a foundry approved casting design for unforeseen circumstances. This happens where the alloy characteristics of the configuration result in a high rejection

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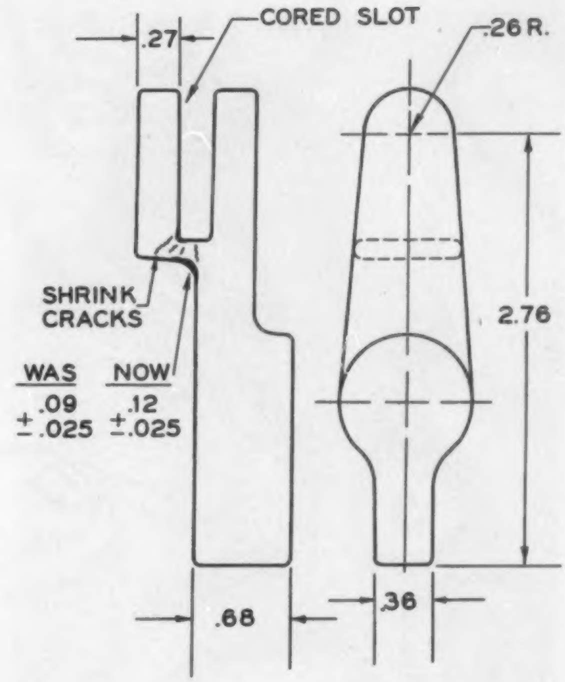


Fig. 1 — A shrink and crack condition of a small shut-off valve arm casting.

rate at final inspection. A minor change may be required to result in 100 per cent acceptable castings of uniform high quality.

The example (Fig. 1) will illustrate a shrink and crack condition of a small shut-off valve arm casting. This was corrected by increasing the radii from 0.09 in. to 0.12 in. ± 0.025 in. The shrink-crack would have been avoided if the cored slot had not been requested in the rough casting to reduce the machining time to a simple skin surface operation. The increased radius was the logical method. Rejects were reduced from 100 per cent to 3 per cent or less.

The cut-away view (Fig. 2) of an engine air duct casting shows where a fine hair crack developed along the 0.09 in. flange which resulted in 100 per cent rejects. A foundry request to increase web section thickness was not permissible as an aluminum skin is rivetted to the highly stressed stepped flange of the duct. However, a dimensional problem occurred on the contour (Fig. 3) after gate removal, where blending of the in-gate stub to the as-cast surface was not in tolerance to over grinding. This type of deviation from an acceptable design will require a compromise with Quality Control, Stress Engineering and the design engineer if acceptable or rejected.

Raw Casting Cost, lb	$41.50
Raw Casting Weight, lb	3
Machined Casting Weight, lb	2.44
Material	A.M.S. 5350

SEVEN DESIGN RULES

The design engineers, through their contacts and intimate workings with the foundryman on a particular steel casting, are alerted that to produce the utmost in the casting seven "rules of thumb" are to be considered. In order to produce the best possible casting for smooth as-cast surfaces with minimum weight and costs, whenever the application of the part will permit:

1. Induce progressive solidification by tapering or gradually decreasing adjoining sections as the distance from the largest center or centers of mass become greater. This is to induce x-ray soundness in the junctions and surfaces.
2. Avoid isolated heavy sections in thin walls which cannot be easily gated or fed by separate risers.
3. Do not add excessive clean-up stock on functional surfaces. This will vary from 0.015 in. to 0.030 in. on castings one to 3 in. in their maximum dimensions, to 0.090 in. to 0.125 in. on larger castings.
4. Fillet design is critical. Excessive fillets cause sections which cannot be fed, and a centerline type

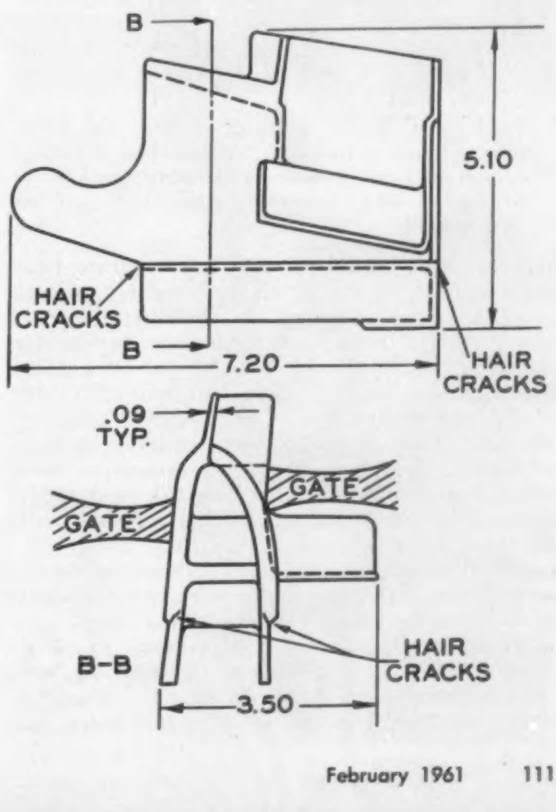


Fig. 2 — A cut-away view of an engine duct casting showing fine hair crack developed along the 0.09 in. flange.

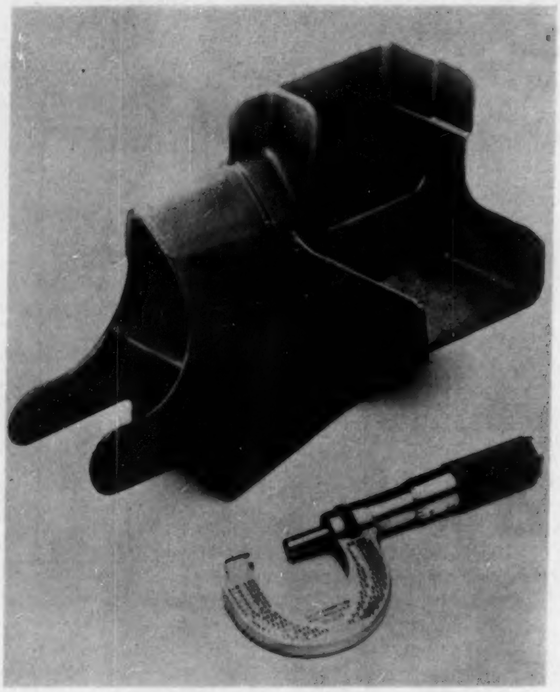


Fig. 3 — Dimensional problem on the contour after gate removal where blending of the ingate stub to the as-cast surface was not in tolerance to over grinding.

porosity will result. Sharp corners ($\frac{1}{64}$-in. R or less) will cause cracks and surface shrinkage.

5. Plain flat surfaces or unbroken gradually curved surfaces, if proportionately larger than adjacent bosses, etc., will have inadequate surface and distortion due to inherent problems while in process. These should be broken by gussets in adjoining corners, ribs and minor corrugations in the surface.
6. Wall thicknesses should be held to a minimum of 0.12 in. on small castings. However, 0.60 in. to 0.090 in. can be held if possible to be fed by adjacent heavy sections.
7. Small holes $\frac{3}{16}$-in. diameter or less, and blind holes with depth in excess of twice their diameter, should be avoided. Cast threads are practical in the ferrous alloys providing Class 2 threads are acceptable.

It is realized that the ideal in a steel casting from the standpoint of design often cannot be attained, owing to factors limiting the engineer to certain conditions of form, contour and metal distribution. But a recognition of effects, due to and controllable by design, represents advantages to both the casting facility and the engineer. Design should not carry the desire for lightness to such a point as to insist on sections throughout the casting, or any part of it, so thin as to either cause serious loss from failure to run or greatly increased cost due to impractically high temperatures.

This latter condition increases both cost and hazard of production, and also produces a casting expensive to finish and often to machine. When liquid metal solidifies, it contracts about 3 per cent in volume. Since metal solidifies progressively from the mold surface to the center of the mold cavity, a contraction cavity will result unless the section is fed from some reservoir containing liquid metal. If the section is unable to draw liquid metal from other sources because these inlets have completely solidified, then a defect will appear in the unfed section.

Castings with defects of this type, under high frequency vibration stress aided by stress centralization, may develop cracks extending from the cavity to the casting face, causing ultimate rupture. If the casting is operating under pressure leaks may develop. The problem of removing the possibilities of defects due to contraction involves the elimination of hot spots in the casting. These isolated hot spots are sources of great trouble in the foundry, and anything that the casting designer can do to eliminate this condition makes for the production of higher quality castings.

RISER PLACEMENT

One of the most difficult problems in designing to prevent contraction cavities is to know when and where feed heads may be placed, since their position is quite largely a matter of personal judgement based upon experience. The casting may be molded contrary to any calculations that may be made if the foundryman is not consulted; the casting may be better designed with the supposition in mind that none of the metal junctions or hot spots can be fed from outside risers. Assuming such procedure, experimentation must be carried on with adjoining sections to determine the extent of the contraction cavity with various changes in design.

This may be further clarified in Fig. 4, where the first production casting attempt by dry sand was not successful because of the shrink and misrun condition in the 0.25 in. and 0.16 in. wall and web section. After repeated relocation of the risers and blind risers in addition to some modification to the design, a complete turnabout was made and the dry sand mold discontinued. A coordinated redesign of the casting was made for the frozen mercury investment process, where the shrink and misrun problems were eliminated with closer dimensional and tolerance control. The raw casting weight savings of the two methods totaled 20 lb (dry sand casting weight 210 lb — frozen mercury process casting weight 190 lb).

Figure 5 shows the drag half of the casting, with the stiffeners on the 0.16 in. web sections from the

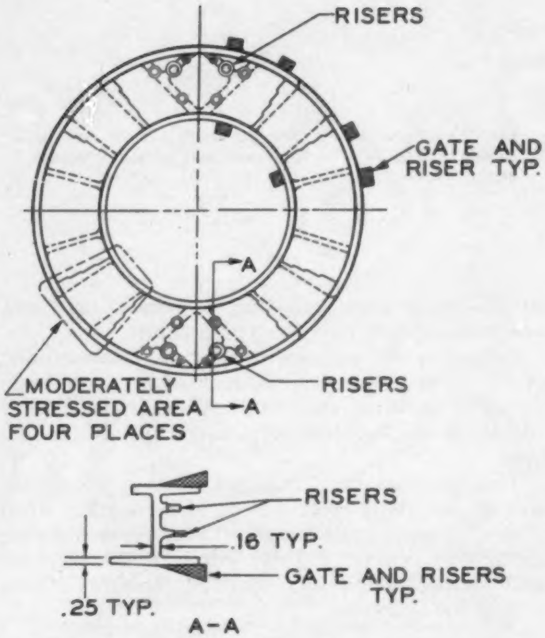


Fig. 4 — The first production casting in dry sand was not successful because of shrink and misrun condition in the 0.25 in. and 0.16 in. wall and web section.

outer diameter ring to the inner diameter ring, acting as additional gating to feed the 0.16 in. web areas that remained as an integral part of the casting. Combination gates and risers are clearly visible on

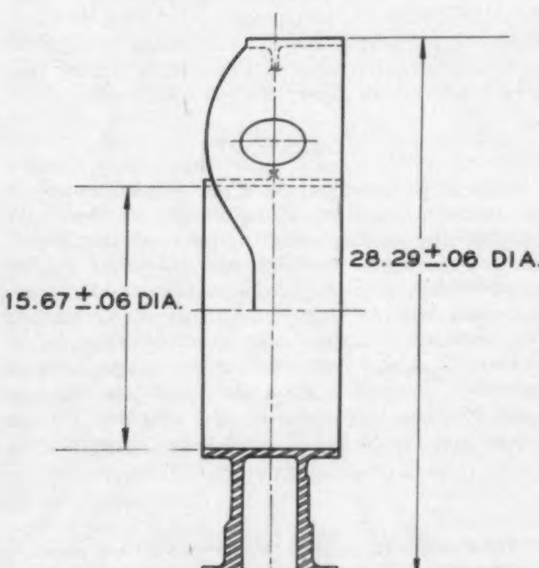


Fig. 4a — Cross-section of "Moderately stressed area, four places" in Fig. 4.

the cope side. Figure 6, cope view, shows the riser locations on the external diameter of ring, with hidden risers located on bosses still intact. Figure 7 is a more direct view of the cope half of the casting with all risers and gating locations clearly visible. This design is an example of approximately the maximum in as-cast weight to date for a missile application steel casting.

WEIGHT CONTROL IMPORTANCE

The design engineer of airframes, missiles and aerospace vehicles are motivated for a particular design concept, where the lighter and smaller the

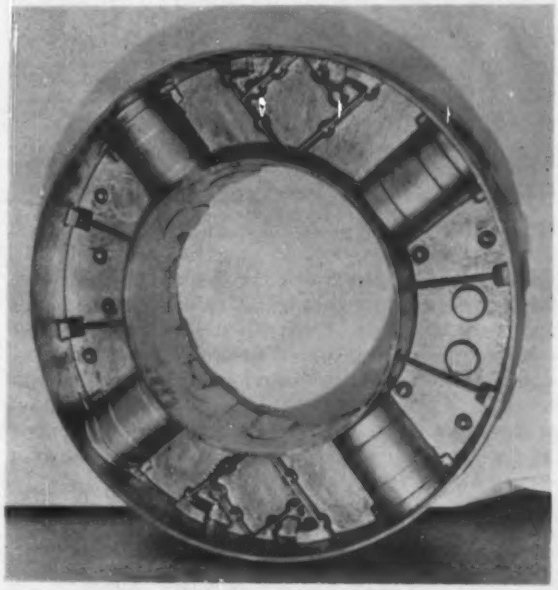


Fig. 5 — Drag half of casting with stiffeners on the 0.16 in. web section from the outer ring to the inner diameter ring which act as additional gating to feed the 0.16 in. web areas that are integral parts of the casting.

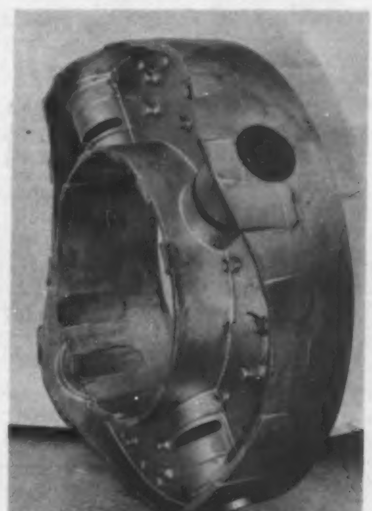


Fig. 6 — Cope view of casting showing riser locations on the external diameter of the ring with hidden risers located on bosses still intact.

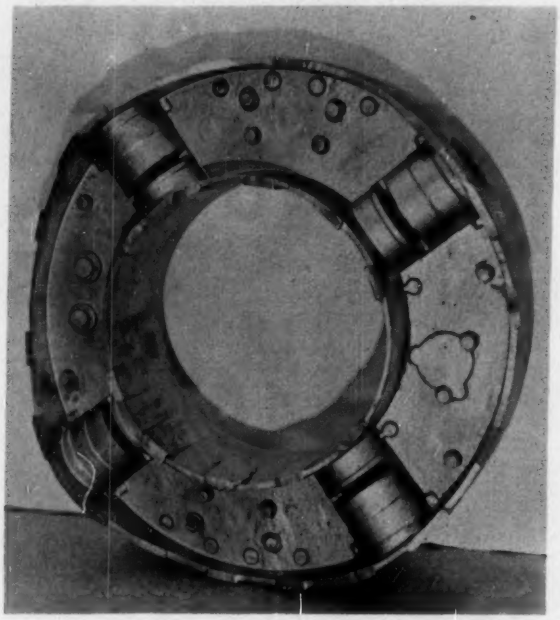


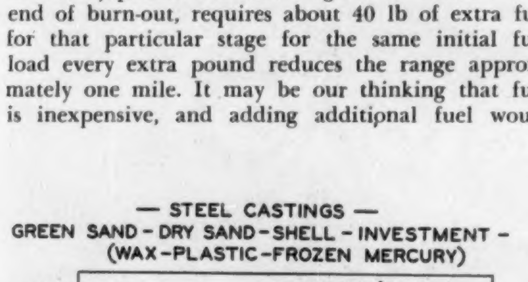
Fig. 7 — More direct view of cope half of casting, shown in Fig. 6, with all risers and gating locations clearly visible.

vehicle the less power will be necessary to acquire the same speed, range and altitude. It is the usual approach to create a hypothetical figure for cost controls of parasitic weight accumulation in a structure. For example, in an airframe one lb of increased weight results in a gross increase of approximately 4 lb, with at least 10 lb gross increase in the high performance vehicles anticipated, at a cost of $10 to $100/lb of structure.

In missiles, this is increased to approximately $400 to $500/lb of structure, and in aerospace vehicles, $4,000 to $5,000/lb of structures. It has been estimated that every pound of added weight to a missile at the end of burn-out, requires about 40 lb of extra fuel for that particular stage for the same initial fuel load every extra pound reduces the range approximately one mile. It may be our thinking that fuel is inexpensive, and adding additional fuel would be less costly than reduction of ounces here and ounces there, from the casting or structure.

Reduction of parasitic weight is recommended as the most economical method when every extra pound in the final stage of multi-stage missiles may require as much as 1000 lb of added fuel in the first stage.

This information is intended for a better understanding of the importance, to the designer, when close dimensional tolerances are noted on the drawing for a steel casting, and the efforts undertaken for maintaining weight accumulation control in the casting and structure.



REJECTION ANALYSIS

An analysis has been made of the steel castings received and placed on salvage because of various discrepancies over a two year period. These data are presented in Fig. 8. The rejection percentages shown are not to be accepted as total scrap or unusable, but to relay to the foundryman the additional handling and paper work necessary after the castings leave the foundry's shipping platform. The greater percentage is delayed by inspection for dimensional tolerances, not conforming to the drawing callout. This is followed by radiograph indications or interpretation, physical properties and minor surface defects. The actual returns to the casting facility vary from 3 per cent to 5 per cent as unacceptable.

CONCLUSION

What is the correct approach to weight control in the castings? Apparently the design engineers are studying the developmental efforts of the higher strength to weight beryllium alloys and the 300,000 psi strength materials. In view of the considerations, assurance must be that every ounce in the casting designed must contain the anticipated values, by insistence on close tolerances. The aircraft industry in general is depending upon the casting facilities to assist in providing some of the solutions for the future, and the advent of Mach 3 and up vehicles.

Fig. 8 — Analysis of steel castings received and placed on salvage because of various discrepancies over a two year period. The rejection percentages shown are not total scrap or unusable, but those requiring additional handling and paper work.

HOT CORE BOX DESIGN AND ENGINEERING

by E. E. Harkess

ABSTRACT

A description of equipment and production processes in the foundries of the author's company is presented, dealing with the use of faster setting binders composed of various combinations of urea and formaldehydefurfural and single stage phenolic resins. Of prime importance in this process is good sand control. The proper measurement of ingredients and timing of their addition during controlled mulling cycle, plus care in sand handling to the machine help make a uniform product on the machine. The hot core box process seems to offer advantages as increased productivity and and material cost reduction.

INTRODUCTION

A large number of foundries currently use the shell process to produce molds and cores in the manufacture of some castings. Probably the most widely used thermosetting sand binders are the phenolic resins. Some plants are experimenting with the use of faster setting binders composed of various combinations of urea and formaldehydefurfural and single stage phenolic resins.

These faster setting binders seem to promise increased productivity. In addition, material cost reduction should encourage increased use of the economical "hot box" method of producing accurate cores. The hot box process offers many advantages, but the process finally selected should be based on a careful appraisal of all production factors involved.

Good sand control is of prime importance. Proper measurement of ingredients and timing of their addition during a carefully controlled mulling cycle, plus care in sand handling to the machine, will help greatly in making a uniform product on the machine. This discussion is limited to a description of equipment and production processes in foundries of the author's company.

CAST IRON CORE BOXES

Our core boxes are made of cast iron, an economical, serviceable material with good heat retention, and relatively good stability when exposed to heat. The boxes are made of S.A.E.-120 cast iron stabilized at 1550 F for a minimum of 30 min, cooled to 1000 F in the furnace in one hr and finally air cooled to room temperature in still air that is 70 F minimum.

The walls surrounding the core cavity are made uniformly to $\frac{7}{8}$-in. thickness, where practical, to help achieve uniform heating. Ribs are designed on the outside of the box to hold its shape when exposed to heat. Copper-base alloy inserts are sometimes used in phenolic resin boxes in critical areas where a faster heat transfer is required. Copper-base alloy inserts are not practical in furfural boxes, because of the corrosive action of the ingredients. Hardened steel is used for locating pins, bushings and wear pads.

HOT CORE BOX DESIGNING

In designing hot boxes, factors related to expansion and contraction must be taken into account to obtain accurate cores. The most important of these factors are:

1. Expansion of cast iron core box when heated to operating temperature (based on a 450 F operating temperature, a 0.003/in. expansion factor is incorporated).
2. Expansion or contraction (determined by materials used) of cores after removal from box.
3. Dimensional change of cores requiring core wash dip and oven redrying.

Another design factor considered is the proper alignment of upper and lower half core boxes. This is usually accomplished by providing three elongated bushings; one on, or near and parallel to the crosswise centerline, and two on and parallel to the lengthwise centerline. On large boxes four bushings are desired; two on and parallel to each centerline, spaced as far apart as is practical. These bushing arrangements minimize misalignment and eliminate binding on locating pins when boxes are heated.

Heat, which is obtained by gas or electricity, is constantly being lost during each operating cycle, and must be replaced as uniformly as possible at a rate that will constantly maintain the desired operating temperature. Box temperature control is especially important when using the faster setting binders because over or under cure is detrimental to core quality.

Electrically heated core boxes have special heater plates attached to the back surface of the box (Fig. 1).

E. E. HARKESS is Plt. Mgr., Ford Cleveland Fdy., Berea, Ohio.

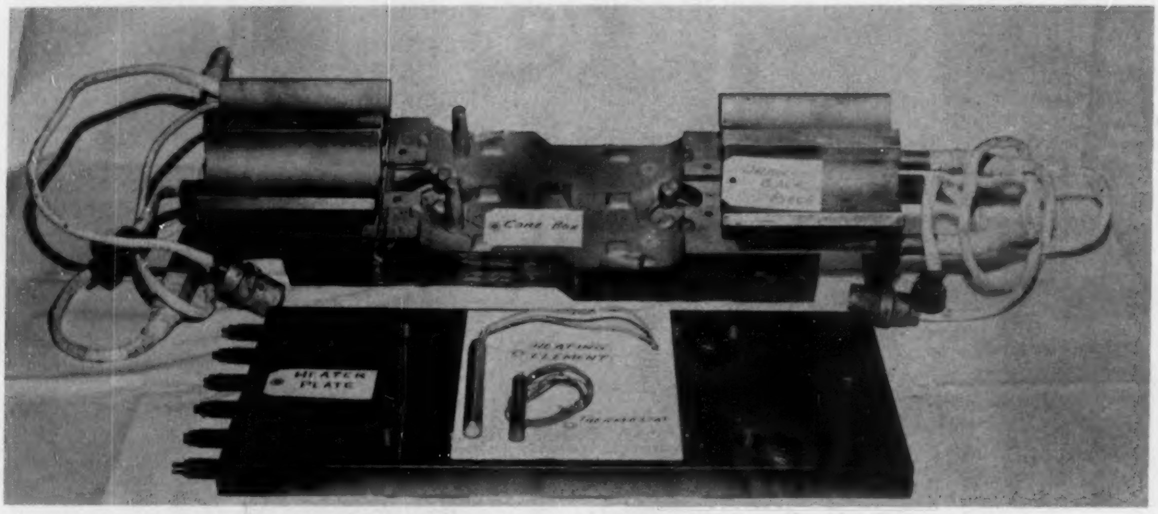


Fig. 1 — Electrically heated core boxes have heater plates attached to the back surface of the core box. Heating elements are cast into these heater plates with leads protruding from the ends.

Heating elements are cast into these heater plates with leads protruding from the ends. Complicated boxes often require cartridge-type heaters adjacent to thin sections or areas excessively cooled during blowing. All electrical elements are thermostatically controlled.

Loose pieces in the core box are sometimes necessary, but they should be avoided because of poor heat transfer. Manual or mechanically operated draw-backs should be substituted whenever possible. Aluminum-bronze "T" slot slides have proved successful as guides for the draw-back pieces.

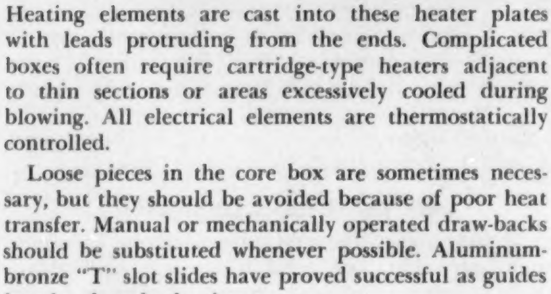


Fig. 2 — Blow plates are water cooled to minimize heat transfer from the box to the sand in the blow holes and in the sand reservoir. Water flows through the water jacket continually while the machine is in operation.

SAND MIXTURES

Core sand mixes containing fast setting binders have a degree of green strength, and can be blown and vented similar to oil sand mixes. Vent screens may be used with tempered sand, but are undesirable for dry mixes which rapidly plug vent screens with free resin abraded from the sand grains. Special provisions are necessary for the dry, free flowing phenolic mixes. Milled vent slots (0.005 in. deep and 1.00 in. wide) are used on partings where possible. Large boxes are vented by providing a gap of 0.012 to 0.017 in. between all partings by means of C.R.S. inserts.

Blow plates are water cooled to minimize heat transfer from the box to the sand in the blow holes and in the sand reservoir (Fig. 2). Water flows through the water jacket continually while the machine is in operation. Blow holes can be the same size for tempered sands as for oil sand mixes. Dry mixes are provided with a baffle over the top of the blow hole in the reservoir, so sand will only drain out of the blow hole until it reaches its angle of repose at the edges of the hole.

Blow tubes in the upper half boxes are tapered to facilitate the ejection of cores. The large end of the blow tubes are located at the core shape. Cores, except those with a shallow draw, are ejected from the box by an ejection mechanism forcing cores from the box by means of pins sliding through blow holes. To reduce core damage, the end of the blow tube is chamfered to insure the blow plug breaking below the surface. This technique is always used where blow holes are on core prints.

Steel discs surround blow holes on the top of upper half core boxes to reduce the area of box contacting the blow plate for minumum heat transfer. When required, additional bearing pads are installed to prevent distortion of core boxes by clamping pressures.

Fig. 3 — A five station rotary machine is used in production of the barrel slab shell core for a V-8 cylinder block at one plant. This machine has a hot upper and lower box at each station.

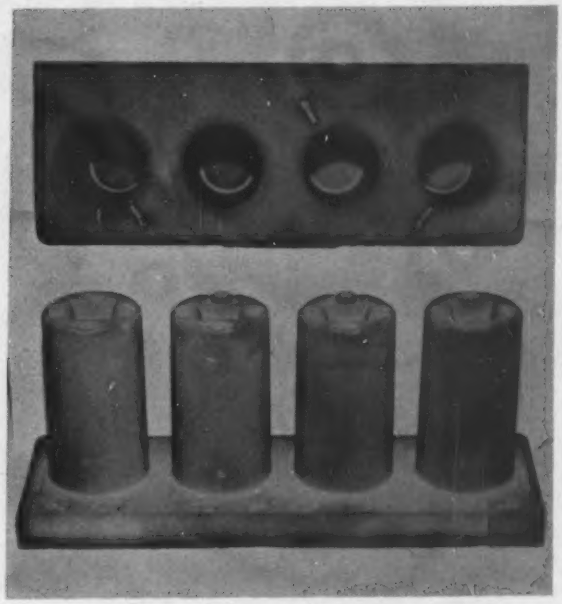


Fig. 4 — After removing the core, the operator blows all sand particles from the boxes and sprays the box with core release.

PROCESS OPERATION

The barrel slab shell core for the V-8 cylinder block is made at the author's company's foundry on a five station rotary machine which has a hot upper and lower box at each station (Fig. 3). Starting at the blow station, the upper and lower half core boxes are raised against the water cooled blow plate, which is fastened to the sand reservoir. The core is blown, the boxes are lowered and cycled into the oven portion of the machine. The boxes are heated by means of gas jets evenly spaced around the inside of the insulated oven.

The boxes are heated through three of the five stations of the machine, and are cycled into the ejection station. At this station, the lower half box is retained in position by engaging cleats while the upper box is raised against pins attached to the ejection plate. With the upward movement of the box, the pins pressing against the blow tips eject the core onto a platform swung into place by the operator.

After removing the core (Fig. 4), the operator blows all sand particles from the boxes and sprays box with core release as required. The upper half box is then lowered into place, and the unit cycles into the blow station. Both the upper and lower half of the core box are hot. The core is always retained in the upper half for ejection purposes.

Barrel slab shell cores for V-8 blocks are made in another foundry of the author's company on a shuttle machine in this way—two units, or boxes, are mounted in a wheeled carriage that shuttles back and fourth between the blow and ejection stations (Fig. 5). This machine permits four cores to be made at each blow. After each blow the unit moves into the ejection station where the upper stripper mechanism engages the core at the blow tube locations. At this point the entire unit remains stationary while gas heat is applied to cure the core. The upper box is then lifted a short distance to strip the box clear of the core.

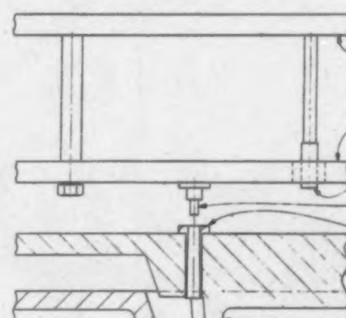


Fig. 5 — Barrel slab shell cores for V-8 blocks are made on a shuttle machine in another plant. Four cores can be made at each blow.

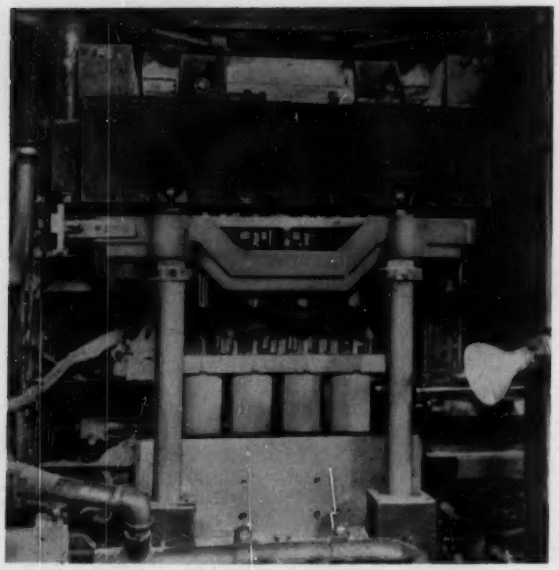


Fig. 6 — Strip mechanism and upper half of core box are raised a sufficient height for core ejection from the lower half box.

Core Ejection

The strip mechanism and upper half box are then raised a sufficient height for core ejection from the lower half (Fig. 6). Next, the ejection mechanism in the lower half box raises the cores to a height sufficient for the pick-off fingers to move into position.

The pick-off fingers raise the cores clear of the box and ejection pins, and then retract for pick off by the operator (Fig. 7). Air and spray lines attached to these fingers clean and spray the box prior to lifting the cores clear of the box. After the cores are removed, the upper half box is lowered into position. The unit is now ready to cycle into blow position. The upper box is heated by gas jets projecting through the stripper mechanism. The lower box is heated by gas jets projecting through the ejection plate.

Flywheel end cores for V-8 blocks are made in this foundry on the same type machine used for production of barrel slab cores. The cutaway view of various parts that make up the unit for this type shell box are shown in Figs. 8, 9 and 10.

The combustion chamber slab core for one automobile cylinder head is made in the author's company's foundry on a six-station rotary machine. The six station machine has a hot lower box at each station, and a cold upper at the blow station only.

Core Box Blowing

At the blow station, the hot lower box is raised against the water cooled upper half which is attached to a flat blow plate bolted to the sand reservoir (Fig. 11). The core is blown, the heated box is lowered and cycled into the oven portion of the machine where it is heated by gas jets through three stations.

In the fourth, or ejection, station the box is retained by engaging cleats (Fig. 12). The ejection piston located beneath the box raises the ejection plate and pins forcing the core clear of the box. The operator manually removes the cores from the two gang box. The ejection plate lowers, and the box cycles into the fifth, or pre-heat, station before going into the blow station (Fig. 13). The ejection pins have 0.005 in. clearance on the radius and are held 0.03 to 0.06 in. above the box surface.

In this foundry, crankcase cores for an automotive cylinder block are made in electrically heated core boxes on a one station roll-over type core blower (Fig. 14). The door piece swings into closed

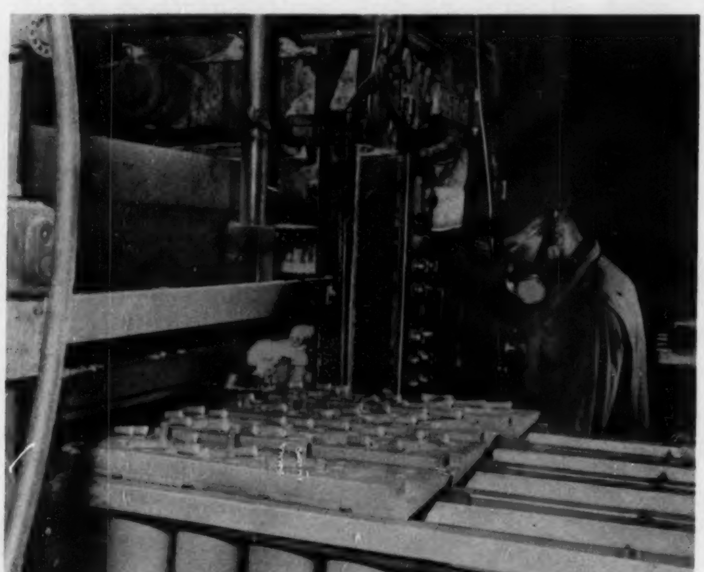
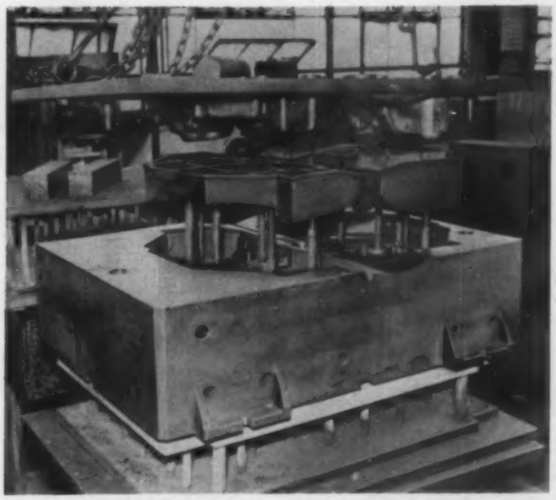
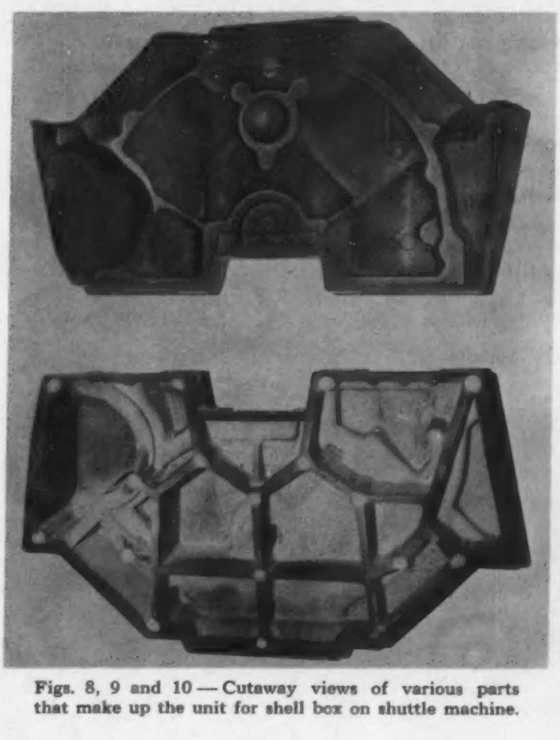


Fig. 7 — Pick-off fingers raise the cores clear of the box and ejection pins and then retract for pick off by the operator.





Figs. 8, 9 and 10 — Cutaway views of various parts that make up the unit for shell box on shuttle machine.

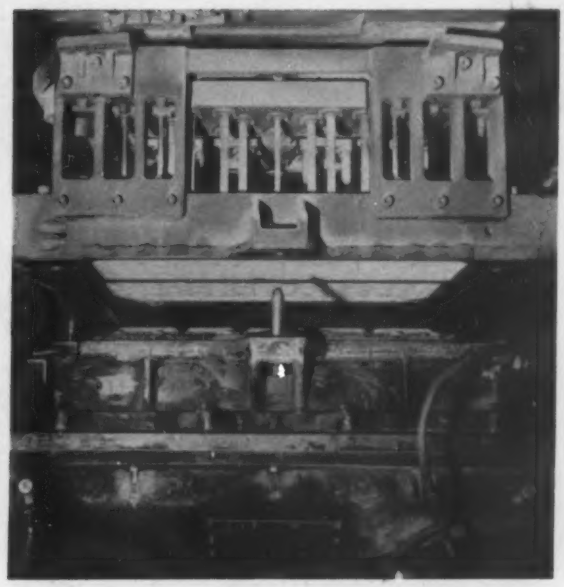


Fig. 11 — At the blow station, the hot lower box is raised against the water cooled upper half and the core is blown.

position; two retractable skirt pieces then move into place; the ram piece moves forward against the door piece; the two side pieces move into position; and the two top end barrel plugs cycle into proper location. The box is ready for blow.

The sand reservoir at the bottom of the machine has an aluminum blow plate attached with a mesh-lined heat resistant rubber gasket fastened to the box

Fig. 12 — At the ejection station the box is retained by engaging cleats. The ejection piston raises the ejection plate and pins forcing the core clear of the box.

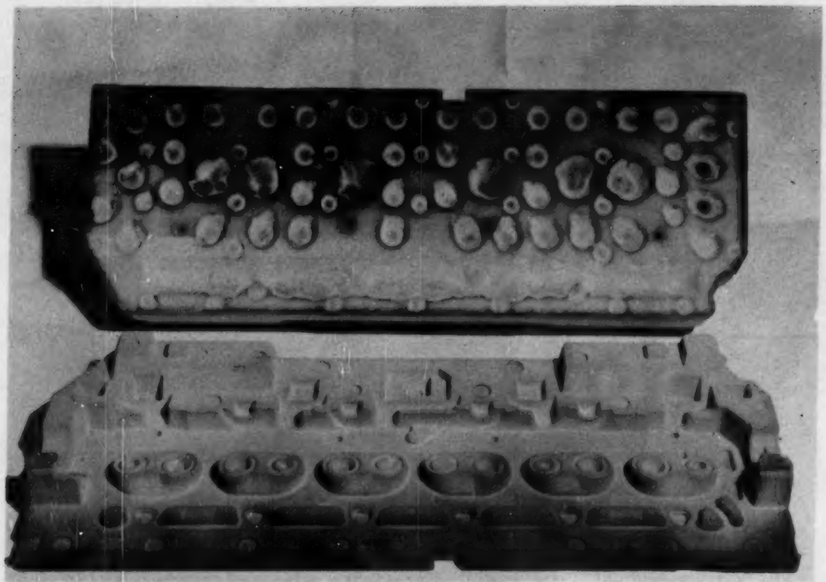


Fig. 13 — After the ejection plate lowers, the box is cycled into the pre-heat station before going into the blow station.

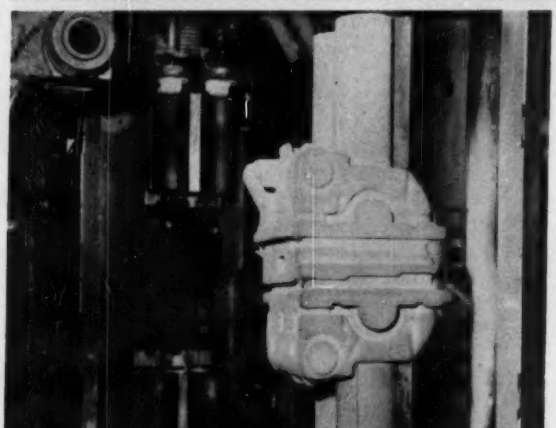


Fig. 14 — Crankcase cores are made in electrically heated core boxes on a one station roll-over type core blower in one foundry. The door piece swings into closed position, two retractable skirt pieces move into position, the ram piece moves against the door piece, two side pieces move into position and the two top end barrel plugs cycle into proper location so the box is ready for blow.

contact surface. This gasket forms a heat transfer barrier and provides a positive seal at blow. Sand reservoir and blow plate are raised against the bottom of the box, and the entire assembly rotates 180 degrees, in which position the core is blown and held for cure. The assembly returns to its original position after rocking back and fourth several times permitting uncured sand to fall back in the reservoir. Following cure time, the side pieces move back; the two skirt drawbacks retract; the ram piece retracts; and finally the door piece swings open with the core adhering to its surface. An air-operated ejection mechanism is used to facilitate removal of the core from the door piece. Figure 15 shows the core piece.

It may be necessary to get the assistance of the product engineer to make some cores practical to make by this method. Elimination of troublesome loose pieces, thin fingers of sand that may not ram well and simplification of box partings are ways in which he can help. Jobs on which the product engineer can be shown that economy and accuracy can be obtained by the use of the hot-box method will usually get his help where he can give it.

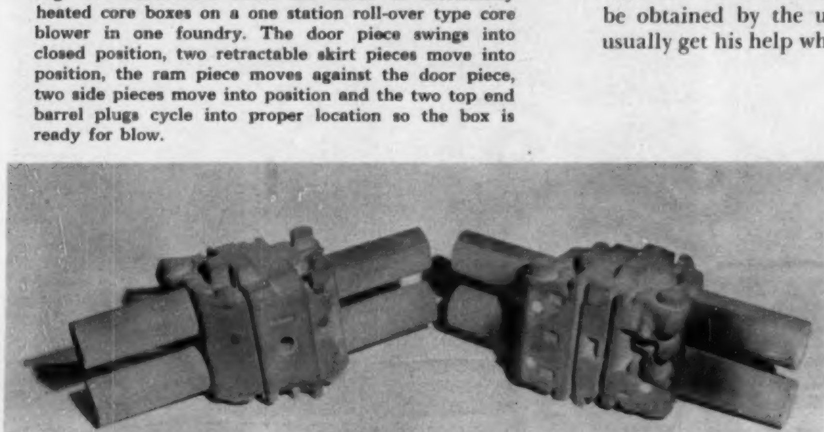


Fig. 15 — Crankcase core made in electrically heated core boxes on the one station roll-over type core blower.

VOLCLAY BENTONITE
NEWS LETTER No. 72

REPORTING NEWS AND DEVELOPMENTS IN THE FOUNDRY USE OF BENTONITE

DIFFERENCES IN IRON OXIDE?

This photo is ample evidence that Klean Surf iron ore oxide is "different" from competitive brands. The P.C.E. Test using Saeger Cones illustrates the difference. There are five cones visible; two white standard Saeger cones and three cones which represent varieties of commercial iron oxide.

The melted Cone No. 11 (arrow) in the foreground represents a temperature of 2345°F. The other white cone (second to the left in the background) is Cone 12 and corresponds to a temperature of 2390°F. There is a slight glaze on this cone. This denotes the P.C.E. furnace was more than 2345°F. and very close to 2390°F.

The three dark cones represent different trade marked iron oxides. The cone marked "B" (a competitive iron oxide) **has not melted!** This means that its melting point is greater than Cone 12 (2390°F.).

The cone marked "C" (another competitive iron oxide) **did not melt** at temperatures corresponding to Cone 12, or 2390°F.

The cone marked "A" is KLEAN SURF iron ore oxide. Note that **the tip has melted and bent,** this is ample evidence of lower melting properties.

This photographic evidence indicates KLEAN SURF **has a lower fusion point than competitive iron oxides marked "B" and "C",** which are more expensive.

In using iron oxides to prevent veining and metal penetration, plastic deformation is required. **Fusing and glazing of a sand mixture assures the foundryman of a better job in eliminating these defects.**

KLEAN SURF does the job best for you! Order through your favorite dealer!

— Write for 6 in 1 brochure —

AMERICAN COLLOID COMPANY

SKOKIE, ILLINOIS • *Producers of Volclay and Panther Creek Bentonite*

Circle No. 155, Pages 145-146

AFS CONVENTION NEWS

SAN FRANCISCO, MAY 8-12, 1961

65th
CASTINGS
CONGRESS

Interest in Congress Papers Hits New High . . . Product Exposition Cancelled

Two important developments concerning the AFS Castings Congress developed this last month.

1. A record number of technical papers has been received to date. This promises an outstanding, well-rounded, industry-wide program.

2. The Products Exposition has been cancelled by the Society's Board of Directors. Dropping the limited Exposition will allow concentration on the 1961 technical program.

With 80 technical papers already set, and many more promised, it is anticipated that at least 100 papers will be presented at the San Francisco Civic Auditorium.

Foundry technology on a world-wide basis will be emphasized. In addition to the U.S. and Canadian Papers, contributions will be made from at least five other countries.

Many of the papers have applications in the West Coast aircraft and missile industries. Included are: "Melting, Casting and Heat Treating Techniques for Structural Uranium Alloy" by G. D. Chandley and D. G. Fleck, Watertown Arsenal, Watertown, Mass.; "Challenge or Compromise with Aircraft Missile Steel Castings" by S. A. McCarthy, McDonnell Aircraft Co., St. Louis; and "Investment Cast Properties of Four Magnesium Base Alloys" by K. Herrick, Tilton Div., Arwood Corp., Tilton, N. H.

Other papers deal with continuing research on fundamental foundry problems. Included are "The Effect of Median Grain Size on the Properties of Green Sand" by A. B. Draper, Pennsylvania State University and H. A. Knappenberger, North Carolina State University; "A Study of the Carbon Dioxide Process" by G. D. Haley, WaiMet Alloys Co., Dearborn, Mich., and J. L. Leach, University of Illinois.

Others are: "Supercooling Measurements and Grain Size Control in Light Alloys" by V. B. Kurfman, Dow Chemical Co., Midland, Mich.; "Compositions and Microstructures of Consistently Weldable As-Cast Nickel-Aluminum Bronze" by M. L. Foster and S. Goldspiel, Brooklyn Naval Shipyard.

Reports also will be given on "Machined Patterns Can be Competitive" by R. Olson, Southern Precision Pattern Works, Inc., Birmingham, Ala.; and "Feeding Distance of Bars in Investment Molds" by H. Present, Arwood Corp., Brooklyn, N. Y.

Principles of the design and use of hot core boxes will be discussed by E. E. Harkness, Ford Motor Co., Cleveland Foundry.

Phillipe Jasson, Regie Nationale des Usines Renault, has prepared a paper on Renault's experiences with the production of cores in hot boxes.

A second overseas contribution will be the official exchange paper of the Institute of British Foundrymen. The paper, "Precision in the Foundry" is by A. Short, Rolls-Royce Foundries, Rolls-Royce, Ltd.

One Canadian paper approved is "Initial Bubble Test for Determination of Hydrogen Content of Molten Aluminum Alloys." Authors are D. J. Neil and A. C. Burr, Aluminum Labs, Ltd.

A new field for foundrymen is opened with the paper "Lightweight Cellular Metal" by L. Polonsky, S. Lipson, and H. Markus of Pitman-Dunn Laboratories, Frankford Arsenal, Philadelphia.

Many of the papers deal with possible revolutionary developments in the foundry industry. Typical is "The Dwight-Lloyd McWane Process as a New Source of Foundry Iron" by T. E. Ban, McDowell Co., Cleveland, and B. W. Worthington, McWane Cast Iron Pipe Co., Birmingham, Ala.

One of the highlights of the Congress will be the annual Edgar Hoyt Lecture to be given by J. C. Caine, technical consultant, who will discuss "Cast Metals and Shapes." He will elaborate on the importance of improving casting performance through casting design.

Exclusive Report on AFS Congress Papers

MODERN CASTINGS will present a complete, copyrighted pre-convention digest of the Casting Congress technical papers. This will be a special technology breakthrough feature which will appear only in MODERN CASTINGS just before the Congress in May.

For the first time, metalcasters will have a complete and interpretive preview of the papers. Specially written summaries designed for both the management and technical executives will appear complete in a special editorial section.

Reservations Open for Hawaiian Tour

Reservations may still be made for the Hawaiian tour. Two plans are available for the Post-Congress tour and adjourned session of the 65th Castings Congress.

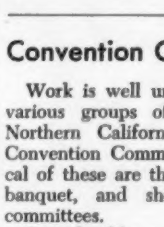
One includes a round-trip by jet airplane leaving San Francisco May 13 and returning May 20. The other consists of a jet flight leaving on May 13 and returning by ship on May 27.

For further details write to AFS Headquarters, Golf & Wolf Roads, Des Plaines, Ill.

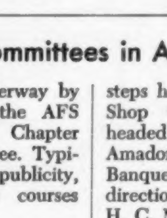
Convention Committees in Action

Work is well underway by various groups of the AFS Northern California Chapter Convention Committee. Typical of these are the publicity, banquet, and shop courses committees.

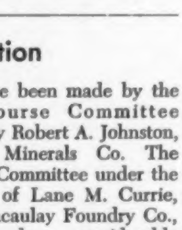
Considerable progress has been made on publicity in the West Coast region by the group headed by J. M. Snyder, National Abrasive Co. Initial steps have been made by the Shop Course Committee headed by Robert A. Johnston, Amador Minerals Co. The Banquet Committee under the direction of Lane M. Currie, H. C. Macaulay Foundry Co., also has done considerable work. A program of nationally known entertainers will be presented rather than a banquet speaker.



L. M. Currie



J. M. Snyder



R. A. Johnston

PICTURE OF MAN MAKING MONEY

Rhude Media Company of Marble, Minn., now enjoys *extra* profits in producing a fine iron powder used in reclaiming low grade iron ore.

Before installing Whiting foundry equipment, Rhude purchased the necessary iron in ingots. Now the company melts its own iron from scrap, using a Whiting #7 Cupola, U-Ladle, and Trambeam® Charging System with two buckets.

The two-bucket cycle assures uninterrupted charging for continuous high output, yet requires only four men in the melting department. Rhude meets customer demands for prompt shipment while enjoying substantial savings.

SEND FOR "METALWORKING PROFILES"

the big, colorful new booklet showing performance reports of Whiting products on the job . . . bringing new efficiency and economy to foundry operations. Ask for booklet 242. *Whiting Corporation, 15628 Lathrop Avenue, Harvey, Illinois.*

Member of the Foundry Equipment Manufacturers Association.

90 OF AMERICA'S "FIRST HUNDRED" CORPORATIONS ARE WHITING CUSTOMERS

WHITING

FOUNDRY EQUIPMENT

MANUFACTURERS OF CRANES; TRAMBEAM® HANDLING SYSTEMS; PRESSUREGRIP; TRACKMOBILES® FOUNDRY, RAILROAD, AND SWENSON CHEMICAL EQUIPMENT

Circle No. 128, Pages 145-146

NEWS and VIEWS

Southeast Regional Feb. 16-17
T&RI Sparks Education
Chapter Funds Assist Students

Contributions to Industry, AFS Bring Recognition to Eight

Eight oustanding foundrymen will be honored at the 65th AFS Castings Congress in May for their contributions to the foundry industry and the Society.

Two will receive AFS Gold Medals, three will be presented with Awards of Scientific Merit, and three will be awarded Service Citations. Nominations were made by the AFS Board of Awards and approved by the AFS Board of Directors.

Gold Medals will be given at the Annual Banquet. Awards of Scientific Merit and Service Citations will be made at the Business Meeting.

Winners are:

Gold Medals

Merton C. Flemings, Jr., Assistant Professor of Metallurgy, Masschusetts Institute of Technology, Cambridge, Mass., the Peter L. Simpson Gold Medal . . . "For oustanding contributions to the casting industry in the application of basic research to production in quality castings, particularly in the light metals field."

William S. Pellini, Head, Metallurgy Department, Naval Research Laboratories, Washington, D. C., the John A. Penton Gold Medal . . "For exceptional contributions to the science of metal casting through leadership in fundamental foundry research at the U. S. Naval Research Laboratories, particularly in the field of heat transfer and flow of metals."

Awards of Scientific Merit

Harvey E. Henderson, Technical Director, Research Department Lynchburg Foundry Co., Lynchburg, Va. . . . "For valuable contributions to metallurgical research in the casting of gray iron and ductile iron."

Theodore R. Schroeder, Foundry Superintendent, Pontiac Motor Div., General Motors Corp., Pontiac, Mich. . . . "For notable contributions to AFS and the foundry industry in the development of a revolutionary process for the production of cores, and new concepts of automated molding and aluminum processing."

Herbert J. Weber, Director of the AFS Safety, Hygiene & Air Pollution Control Program, . . . "For exceptional services to the Society and foundry industry in directing the program for the betterment of the industrial community.

Service Citations

Alexander D. Barczak, Operations Vice-President, Superior Foundry, Inc., Cleveland . . . "For outstanding and inspirational services to AFS, its chapters and the ferrous foundry industry, for inspirational encouragement of young men to foundry careers, and for constant willingness to help the other fellow."

Kenneth M. Smith, Staff Engineer, Caterpillar Tractor Co., Peoria, Ill., . . . "For noteworthy contributions to the Society and the metalcasting industry in the development of engineering principles to make the foundry 'a better place to work.'"

Jess Toth, Vice-President, Sales, Harry W. Dietert Co., Detroit . . . "For his dedication to the principles of AFS and long, continuous service to the Society and the castings industry, particularly in the field of education."

Wisconsin Regional Foundry Meeting Set for Feb. 9-10

Simultaneous technical sessions will be conducted on both days of the Wisconsin Regional Foundry Conference to be held Feb. 9-10 at the Schroeder Hotel, Milwaukee.

Technical papers will be presented at general sessions as well as at five specific divisions; gray iron, steel, malleable, non-ferrous, and pattern. Larry Krueger, Pelton Steel Castings Co., is general conference chairman.

Name Jeffery as FEF Trustee

AFS National Director Warren C. Jeffery, product development manager, McWane Cast Iron Pipe Co., Birmingham, Ala., has been named as an AFS Trustee to the Foundry Educational Foundation. He will serve a two-year term, 1961-1963.

N. N. Amrhein, Federal Malleable Co., West Allis, Wis., is the other AFS Trustee. His term expires in 1962.

Nominations for AFS honors were made by the AFS Board of Awards in a meeting held at the AFS headquarters. Clockwise are: F. W. Shipley, Caterpillar Tractor Co., Peoria, Ill.; F. J. Dost, Sterling Foundry Co., Wellington, Ohio; B. L. Simpson, National Engineering Co., Chicago. Also: C. L. Carter, Albion Malleable Iron Co., Albion, Mich.; AFS General Manager W. W. Maloney; H. W. Dietert, Harry W. Dietert Co., Detroit; L. H. Durdin, Dixie Bronze Co., Birmingham, Ala.; C. E. Nelson, Dow Chemical Co., Midland, Mich. Members of the committee are former AFS presidents.

Present T & RI Courses to Advance Personnel

Five AFS Training & Research Institue courses will be presented during the next two months in the United States and Canada. Three will be held in cooperation with AFS Chapters.

The courses are designed to upgrade foundry personnel and to aid the industry in fulfilling the need for practical, scientific, and technical training of its employees.

The following courses will be presented during February and March:

Sand Control & Technology, Feb. 13-15, Chattanooga, Tenn., Course No. 3 Fee, $60. An instructional course for foundrymen having some experience in sand testing, control, and technology. Course will cover mold wall movement, hot deformation, creep deformation, mold atmosphere, heat transfer, mechanical properties, and metal penetration. Held in cooperation with the Tennessee Chapter.

Production of Ductile Iron, Feb. 22-24, Chicago, Course No. 4, $60. A specialized course for personnel producing ductile iron or contemplating entering the field. All production phases are presented including metallurgy, inoculants, quality control, pouring practices, raw materials, and inspection methods.

Preventive Maintenance, March 2-3, Hamilton, Ont., Canada, Course No. 5, $45. Valuable instruction for foremen, supervisors, plant engineers, and management. Included are the economics of a good preventive maintenance program, organization, and job scheduling. How to reduce down time and maintain practical inventory control are also discussed. Held in cooperation with the Ontario Chapter.

Shell Molds & Cores, March 8-10, Birmingham, Ala., Course No. 6, $60. A critical study of its application, problems, and practical solutions for cost reduction. Covers methods of production and planning, mixes, mulling cycles, resins, sand, and operating problems. Typical case problems are encouraged for class discussion. Presented in cooperation with the Birmingham Chapter.

Economical Purchasing of Foundry Materials, March 27-29, Chicago, Course No. 7, $60. Presents up-to-date information on all aspects of foundry materials purchasing, including inventory control. Gives detailed instruction on buying of scrap, refractories, sand, alloys, binders, core oil, additives, and insurance. Valuable to supervisors, engineers, puchasing agents, foremen, and management.

Future plans for the AFS Training & Research Institute were discussed recently at AFS Headquarters during the annual meeting of the Training & Research Institute Trustees. The group also reviewed past operations.

Members of the Sand Division Casting Quality Committee meeting recently in Chicago made further progress on compiling material for the new handbook.

At a recent committee meeting, work was continued on the AFS book Recommended Practices for Casting Light Metals. The meeting was at AFS Headquarters.

Nominations for AFS Officers and Directors were made recently at Society Headquarters. The Nominating Committee, shown clockwise: Harry Reitinger, Sr., industrial engineer, Beverley, N. J.; E. W. O'Brien, American Steel & Pump Corp., Oklahoma Steel Castings Div., Tulsa, Okla.; R. A. Payne, Sterling Brass Foundry, Inc., Elkhart, Ind.

Also: AFS General Manager Wm. W. Maloney; C. E. Nelson, Dow Metal Products Co., Div., Dow Chemical Co.; Midland, Mich.; L. H. Durdin, Dixie Bronze Co., Birmingham, Ala.; J. A. Barrett, National Malleable & Steel Castings Co., Indianapolis; J. C. Henderson, Omaha Steels Works, Omaha, Neb.; and L. H. Brogley, International Harvester Co., Rock Island, Ill.

CHAPTER NEWS

Southeast Regional Set for Feb. 16-17

Ten technical talks will highlight the Southeastern Regional Foundry Conference to be held Feb. 16-17, the Read House, Chattanooga, Tenn. The conference is sponsored by the AFS Tennessee and Birmingham Chapters and the University of Alabama Student Chapter.

Included in the tentative program are:

"Future of the Foundry Industry," C. A. Sanders, American Colloid Co., Skokie, Ill.

"Water-Cooled Cupola Operation," H. W. Schwengel, Modern Equipment Co., Port Washington, Wis.

"Foundry Cost Analysis," Harry Kessler, Sorbo-Mat Process Engineers, St. Louis.

"Core and Mold Blowing," L. D. Pridmore, International Molding Machine Co., LaGrange Park, Ill.

"Save on Grinding and Cut-off," John A. Mueller, Carborundum Co., Niagara Falls, N. Y.

Subject to be announced, T. E. Barlow, Eastern Clay Products Dept., International Minerals & Chemical Corp., Skokie, Ill.

"Aluminum Risering, Feeding, Degassing, and Grain Refining," D. E. Wyman, Exomet, Inc., Conneaut, O.

"Foundry Ventilation, Common Mistakes," H. J. Weber, AFS Director of Safety, Hygiene, and Air Pollution Control.

"Carbon Control in Acid Cupola Melting," W. W. Levi, consultant, Radford, Va.

"Sand Reclamation," E. C. Troy, National Engineering Co., Chicago.

Herman Bohr, Jr., Robbins & Bohr, Chattanooga, Tenn., is general conference chairman. James L. Payne, Ross-Meehan Foundries, Inc., Chattanooga, is program chairman.

PITTSBURGH—Prof. B. W. Niebel, Department of Industrial Engineering, Pennsylvania State University, discusses engineering analysis and design in the foundry.—by Walter Napp

Central New York Chapter

Joins Technical Council

Membership has been taken by the chapter in the Technical Societies Council of Greater Syracuse.

This society has a four-fold purpose: 1. To promote the public welfare through technical and engineering knowledge and experience; 2. To further the collective activities of technical and engineering societies in Central New York; 3. To handle such matters as may jointly concern member groups; 4. To encourage education and study in areas of council interest.

Ontario Chapter

Pearlitic Malleable Iron

Canadian ductile iron producers must improve their marketing techniques, said Andrew Kavosi, Auto Specialties Mfg. Co. The speaker pointed out that ductile iron possesses many superior qualities which had not been brought to the attention of customers.

J. O. Edwards, supervisor, non-ferrous section, Department of Mines, outlined theories involved in casting bronze alloys, including gating and risering, chilling, sprues, gas porosity, steam porosity, and hot tears.—by Paul B. Walters and T. H. Slater

Quad City Chapter

Japanese Foundry Industry

Observations resulting from a three-month technical consulting project in Japan were given by Prof. C. C. Sigerfoos, Michigan State University.

He commented on the impact of competition offered by Japanese castings on the world market and told of the advancements in metallurgy, cupola practice, sand control, and mechanization.

The project was sponsored by the International Cooperation Administration and was carried out in 45 foundries in Tokyo, Nagoya, Osaka, and Kobe. Technical seminars were held in these industrial areas.—by Leo E. Osbourne

NORTHEASTERN OHIO—Ferrous speaker Joseph Stana, Warner & Swasey Co., left, and technical chairman William Mahoney, Madison Foundry Co.—by Sterling Farmer

QUAD-CITY—Status of the Japanese foundry industry was explained by Prof. C. C. Sigerfoos, Michigan State University (right). Sigerfoos recently completed a three month technical consulting project. On left is John Gumpert, M. A. Bell Co., technical chairman. —by Leo E. Osbourne

Michiana Chapter

Silicosis in Foundries

Seven out of eight foundries have the silicosis problem under control, Dr. O. A. Sanders told chapter members. A study of the problems shows that less than 1 per cent of cases occur in brass foundries; as many as 15 per cent in large steel foundries, 7-8 per cent in gray iron foundries, and 10 per cent in malleable foundries.

Dr. Sanders also stated that silica parting can be dangerous but that the major exposure today is from iron dust. Silica is not as irritating to bronchial tissue as cigarette smoke or coal smoke, and there is very little silica problems from shakeout, he observed.

Dr. Sanders stated that shell molding is a potential hazard due to the fine sand used but that there has not been sufficient study to reach a definite conclusion.

He added that silicosis is not always disabling and men need not be taken off the job except in the most advance cases. Silicosis can be prevented by an adequate dust collection system. —by Joseph Lazzara

NORTHEASTERN OHIO—Ray Sutter, Sutter Products Co., Holly Mich., right, speaker at the pattern session, discusses program with technical chairman Bud Goodman, Ford Motor Co., Cleveland Foundry.—by Sterling Farmer

Twin City Chapter

More Efficient Air Use

Recommendations for more efficient use of air-powered hand tools were made by Burton L. Ballard, Ingersoll-Rand Co.

Chief losses of air may be traced to valve stem packing, leaky shut-off valves, leaky valves on tools, and poor hose clamps. Ballard used tables to emphasize pressure drops due to misapplication of pipe size, spuds, nipples, and members. His corrective suggestions include: use a loop system where possible, place heavy intermittent demands at the ends of long lines, cool air immediately after compression, use automatic traps to insure drainage, use large radius bends, and keep air hoses off the floor. A planned retooling program was suggested for maximum efficiency. —by Matt Granlund

Southern California Chapter

Holds Casting Clinic

Problem castings from local foundries were studied and recommendations advanced at the annual casting clinic.

Panel and panel members were: *ductile iron*, R. M. Dollin, Dayton Foundry and William D. Emmett, Steel Casting Co.; *gray iron*, R. E. Juhnke, Globe Foundry; *steel*, Gene Nutter Alloy Steel & Metal Co.; *brass;* Edward Fratello, Ampso Metal, Inc.; and *aluminum*, Gerry Hewett, AiResearch, Inc.

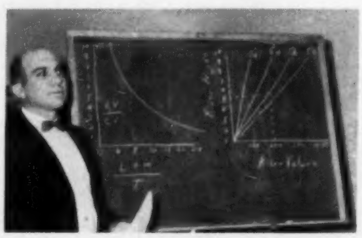
John M. Thomas, Lincoln Foundry Co., summarized with a series of problems common to all types of foundries—by R. V. Gragan

PITTSBURGH—Shown at head table are immediate past President J. D. Wilson, W. P. Winter and speaker B. W. Nibel, Pennsylvania State University; and Chapter Educational Chairman J. O. Denny, J. S. McCormick Co.—by Walter Napp

ONTARIO—Recent developments in ductile iron production were outlined by R. C. Shnay, Canada Iron Foundries, Ltd., Toronto, Ont., left. Others are J. O. Edwards and A. Kavosi.—by E. Skelly

CHICAGO—Prof. H. L. Womochel, Michigan State University, right, discussed mold wall movement at a sectional meeting. On left is technical chairman M. E. Saxman.—by George DiSylvestro

CENTRAL MICHIGAN—S. H. Pasick, Battle Creek Foundry Co., and former Chapter Chairman (left) receives a watch and congratulations from Chairman D. E. Dice, Albion Malleable Iron Co.



CHICAGO—Gating and risering of steel castings is explained by Albert De Girolamo, Electrocast Steel Foundry, a member of a three-man panel at a recent meeting.—by George DiSylvestro

MID-SOUTH—Efficient cupola use was explained by S. S. Phillips, right, Ohio Ferro Alloys Corp. Others are Chairman J. R. Karlovic and Vice-Chairman R. C. Morin.—by E. J. Johnson and T. Barbour

WISCONSIN—Arrangements for the annual party were handled by Co-Chairman Henry Seeboth, left, and R. F. Amrhein, right.—by Bob DeBroux

DETROIT—The Hon. Paul Martin of the Canadian Parliament, right, congratulates speaker I. G. Needles at joint meeting of the Detroit Chapter.

Texas Chapter

What's New in Non-Ferrous

New competition coming from new materials, as well as established processes must be met in an aggressive manner, stated R. A. Colton, Federated Metals Div., American Smelting & Refining Co., Houston.

He cited new competitive techniques as: dispersion of dissimilar materials, explosive forming, impact extrusion, non-ferrous forging, die casting including the new vacuum techniques, and the various techniques of joining metals.

In addition to new processes, Colton said there are a variety of new alloys and metals now available to the engineer. These include tungsten, molybdenum, tantalum, niobium, spent uranium, all of which represent a threat to some established material, although not necessarily aluminum or copperbase alloys.

"To combat this new competition," said Colton, "the non-ferrous industry has made considerable strides in a number of fields." He listed new alloys such as the PT group of aluminum casting alloys, beryllium coppers, new aluminum bronzes, high purity aluminum casting alloys, as well as variations of established alloys.

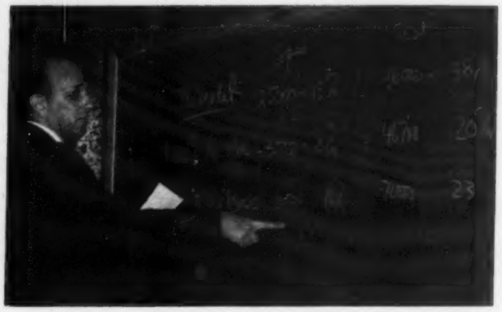
New techniques of manufacturing are being used to produce higher quality and more economical castings. Among these, Colton described the process used by Chevrolet to make aluminum engine blocks, the centrifuging of permanent molds, trail process molding, as well as technological improvements of older practices.

In addition, the non-ferrous industry is fighting back by improving its marketing, merchandising, and investigations into how to better use non-ferrous materials. Particularly cited was the Brass & Bronze Ingot Institute's research program at Battelle Memorial Institute which has developed higher physical properties in commonly used copper-base alloys.

Other efforts include: sponsoring work by the AFS Brass & Bronze Division at the University of Michigan to develop better ways of producing sound copper-base castings; the program of the Non-Ferrous Founders Society in producing a new manual on the use of non-ferrous castings for the casting customer; a new book by the Cast Bearing Bronze Institute; and efforts by the Copper & Brass Research Association.

Colton predicted through programs of these associations the non-ferrous industry will be able to regain many applications.—by C. Eugene Silver

WESTERN MICHIGAN—Speaker William Weaver, Modern Pattern & Plastics Co., second from right, explains new applications in plastic patternmaking to V. Pyle, Chapter Chairman W. A. Blackmer, and Program Chairman R. Williams.—by J. L. Brooks



TEXAS—R. A. Colton, Federated Metals Div., American Smelting & Refining Co., illustrates point in his talk on new developments in the non-ferrous casting industry.—by C. Eugene Silver

PITTSBURGH—Many years in the foundry industry are represented by this trio, C. M. Kelly and Joe Froehlic, both of Sterritt-Thomas Foundry Co., and Charles Goodnough of Shaefer-Goodnough Co.—by Walter Napp

OREGON STATE COLLEGE—Members of the student chapter recently toured Precision Castparts Corp., Portland, Ore., and observed the investment casting of exotic metals for the missile industry.—J. R. Neidhart

NORTHWESTERN PENNSYLVANIA—Nearly 300 foundrymen and their wives attended the annual party. Members of the entertainment committee are Jack Gordon, Alex Morschhauser, James Pace, Paul Green, and Peter Pascale.—by Walter Napp

Metallurgical Society Names Four Professors

Four university professors associated with the teaching of metallurgy, have been elected into honorary membership of Alpha Sigma Mu, the honorary metallurgical fraternity.

Those elected were: Prof. Ettore A. Peretti, University of Notre Dame; Prof. Andrew H. Larson, Missouri School of Mines and Metallurgy; Prof. George J. Fischer, Polytechnic Institute of Brooklyn; and Prof. Victor Franceschini, Polytechnic Institute of Brooklyn.

Alpha Sigma Mu was established in 1932 at Michigan College of Mining and Technology to recognize outstanding scholarship among students specializing in the arts and sciences of metals.

The present membership is about 1000 and includes students from approximately 25 schools which grant degrees in metallurgy. The Society has eight chapters; Michigan College of Mining & Technology, University of Illinois, Virginia Polytechnic Institute, Missouri School of Mines and Metallurgy, Wayne State University, New York University, University of Maryland, and Polytechnic Institute of Brooklyn.

Publish Symposium on Metal Solidification

A symposium on solidification, consisting of papers presented at the 64th Castings Congress & Exposition, has been published by AFS.

Papers in SYMPOSIUM ON SOLIDIFICATION are: "Solidification of Metals," G. W. Form and J. F. Wallace; "Solidification of Steel Castings," C. W. Briggs; "Solidification of Cast Iron," C. K. Donoho; "Solidification of Aluminum Alloys," M. C. Flemings, S. Z. Uram, and H. F. Taylor; "Solidification of Copper Alloys," R. W. Ruddle; and "Solidification of Metals," W. K. Bock.

These papers were co-sponsored by the Fundamental Papers and Heat Transfer committees. Member price for the 56-page book is $2.25; nonmembers, $3.50.

Schedule 1961 Missouri Regional

The 1961 Missouri Valley Regional Foundry Conference will be held Sept. 21-22 at the Rolla School of Mines, Rolla, Mo.

Chesapeake Chapter

Holds Annual Picnic

One of the most unusual chapter events in the Society is the annual Chesapeake oyster roast. It was recently held for the twelfth time. The menu includes raw oysters and clams, oyster stew, oyster fritters, fried oysters, roast beef, steamed frankfurters in sauerkraut, relishes and beverages.

Central Illinois Chapter

Looking at the Future

Recent foundry developments in the United States and abroad were outlined by Clyde A. Sanders, American Colloid Co., Skokie, Ill. Among topics discussed were thermo-hardening materials for the coreroom, direct reduction of ore to molten metal, and mechanization of molding operations. Fourteen of the past chapter chairmen were present for past chairmen's night.—by Charles W. Search

Rochester Chapter

Snagging and Cut-Off

General rules for grinding wheel selection and operation were advanced recently by John A. Mueller, Carborundum Co. Five recommendations were advanced:

Use the coarsest grit permissible.

Maintain the correct break-down speed. It is essential to use a dense structure with high wheel speeds.

Use constant surface feet per minute for the most efficient operation.

Obtain the true costs for grinding; labor costs must be figured in most grinding operations. The most economical wheel may not be the cheapest priced wheel.—by Robert Dill

San Antonio Section

Study Practical Problem

Altering the sand mix was advanced as a possible solution to warped castings submitted for study by a local foundry. The theory was advanced after group discussion. The problem involved castings that warped despite the fact that the cores remained straight.

A second problem casting was a flanged hub which was subjected to shrinkage. Gating was on the hub only. The solution advanced was to gate on the flange as well as on the hub.

A third problem was a gear blank which exhibited a hole when the riser was broken off. The solution advanced was to change the risering system.—by Frank Page

Beloit Foundry Holds Annual Party

AFS General Manager Wm. W. Maloney, Bert Baptist; Harry Moore, Beloit president; George Dietrich, executive vice-president of Beloit-Italia; go through serving line.

Foundry workers at Beloit Iron Works, Beloit, Wis., again held their unique no-lost-production time Christmas party initiated in 1953. Over 600 workers were served at three parties, one for each shift, right in the coreroom. It is strictly a foundry affair and "on" the supervisors, with office girls serving lunch during the normal time. Bert Baptist, manager of the foundry division, claims the affair is "one of the high points of the year and has created more good will than anyone could imagine."

Ten years ago Beloit Iron Works decided to do something about their foundry's Christmas spirit. Nuts and candy were passed out for the first couple of years. This developed into the Christmas party seven years ago.

Northeastern Ohio Chapter

Role of Foundry Foreman

The role of the foreman in industry would be improved if top and middle management would define and recognize his position, said Joseph M. Stana, Warner & Swasey Co. He advocated that foremen be given authority in their departments and be consulted before higher management makes decisions affecting his department.

Among the duties of foreman should be looking after the welfare of his workers, inform them of the department standards, teach new workers, promote qualified personnel, keep abreast of new technical developments, and contribute to community affairs.

R. A. Flinn, technical director, Non-Ferrous Founders' Society, described the work done by the AFS Brass & Bronze Research Committee on the pressure tightness of 85-5-5-5 and other alloys.

Patternmakers heard R. H. Sutter, Sutter Products Co., discuss "Hot Corebox Adaptation and Cores." He described patterns and core boxes used for the production of a variety of shell molds and shell cores and touched on development of core boxes for the quick-setting sand binders. —by William G. Gude, Robert H. Herrmann, and Wallace D. Huskonen.

Detroit Chapter

International Night

Members of the Detroit Chapter were guests recently of the Ontario Chapter meeting in Windsor, Ont.

Europe's industrial resurgence and what it means to North America was discussed by Ira G. Needles, formerly Goodrich Rubber Co., Canada, Ltd., board chairman. He was introduced by the Hon. Paul Martin, Canadian Parliament member.

Needles warned that North America is pricing itself out of foreign markets and that this country and Canada must regain the initiative.

AFS General Manager Wm. W. Maloney also addressed the joint meeting of the chapters. One hundred persons attended the meeting with Ontario Chapter Chairman Mynard D. Bleaken presiding.—by Joseph Barron, Jr.

Tri-State Chapter

Annual Christmas Party

Two hundred members and guests attended the annual Christmas party held at the Hotel Tulsa, Tulsa, Okla. As has been the custom, each couple donated a child's gift for distribution by Salvation Army.—by Bobby Bell.

Publish Cupola Book In Spanish

Publication of the AFS Cupola and Its Operation is now available in a Spanish translation through The Compania Editorial Continental, S.A., Calz. de Thalpan No. 4620, Mexico 22, D.F.

The Spanish edition, entitled, "El Horno De Cubilote Y Su Operacion," contains 967 pages consisting of four major sections; operations, equipment, materials; and principles related to cupola operation. Each of these subjects, as in the original AFS edition, are discussed in detail. In addition to the five chapters a complete appendix is included. It is designed for quick reference and is extremely legible. The translation, also like the original, is liberally illustrated.

Those interested in the Spanish edition should contact the publisher direct, the address of which appears above.

Still Time to Enter Apprentice Contest

Ample time remains for chapters and plants to participate in the AFS National Apprentice Contest. However, all local contests should be completed by March 17 to allow for shipping and completing records.

All entries in the national competition must be received at the University of Illinois, Navy Pier, Chicago, not later than 5:00 pm, March 31.

The contest is open to any trainee in the metalcasting industry who has not had more than five years patternmaking experience, nor more than four years molding experience. Competition is held in two patternmaking divisions, wood and metal; and three molding divisions, non-ferrous, steel, and gray iron.

Three prizes will be awarded in national competition for each of the five divisions. Each first place winner will receive $100, second place, $75, and third place, $50.

All plants and chapters holding local elimination contests must furnish to AFS Headquarters the name of one person to be the official contact for all correspondence concerning the contest. Prior to the actual receipt of entries for judging, all contest activities and correspondence should be addressed only to the Education Director, Golf and Wolf Roads, Des Plaines, Ill.

Entries in national judging may come from one of four sources:

1. Chapter contests.
2. Inter-plant contests (three or more plants).
3. Individual plants.
4. Individual entries.

When an AFS chapter conducts a contest, all individual plants and individual entries within its limits must clear through the chapter. Inter-plant contests are not required to work through local chapters.

In both chapter-sponsored contests and inter-plant contests, three entries from each of the five divisions are eligible for national judging. Individual plants may submit only the winning entry in each division.

National entries must be shipped prepaid only to Prof. R. W. Schroeder, University of Illinois, Navy Pier, Chicago.

CANTON—How to obtain more profitable foundry operations were explained by Harry E. Figgie, Jr., at rostrum. Others are Nicholas Petros, Canton Malleable Iron Co., Chairman R. A. Dun, and AFS National Director R. E. Mittlestead.—by Charles Stroup

NORTHERN CALIFORNIA—Getting heads together are Chapter President H. F. Prior, Superior Electrocast Foundry Co.; Vice-President M. E. Ginty, Vulcan Foundry Co.; AFS National Director A. E. Falk, Centrifugal Castings Co., and the speaker, J. E. Kiesler, General Electric Co., Schenectady, N. Y.—by E. J. Ritelli

WESTERN NEW YORK—Principles of veining and penetration were explained by George DiSylvestro, American Colloid Co., Skokie, Ill. Shown are Chapter Chairman Ed. O'Connell, speaker DiSylvestro, and Technical Chairman S. Santomieri.—by Don Kreuder

DETROIT—Members were guests recently of the Ontario Chapter at the annual International Night. Left to right: Detroit Chapter Chairman Roger VanDerKar, AFS General Manager Wm. W. Maloney, and Ontario Chapter Chairman Maynard D. Bleaken.—by J. H. Barron

NEW ENGLAND—Arrangements for the annual ladies night were headed by 1st Vice-President L. W. Greenslade, Jr., and Director W. C. Naughton shown with wives prior to party.—by Joseph Orrok

Cooperative Training Program Gets Student Approval

The need for "young blood" in the foundry industry is a continuing problem. Sparking interest of young people to enter the metalcasting field is the responsibility of every member of the industry.

Generated on the national level through continuing AFS programs, it must be carried on at the local level through AFS chapters.

Serving as a guidepost is the scholarship program which the Central Michigan Chapter has undertaken at Western Michigan University. The value of such a plan to the industry, to individual foundries, and to the students are best told by one recipient of such a scholarship.

Student Harold E. Clipfell outlines his experience with the cooperative plan while employed by Dock Foundry Co., Three Rivers, Mich. Reports Harold:

Practical Experience

"At the start I was the only production operator. After several weeks I had more experience with the machine than anyone in our foundry. This experience put me in a unique position of an authority on the shell core machine.

"Thus, when problems arose on the machine, I could advise and make suggestions based on my working experience. During the time in which I operated, I also set-up. This is quite complicated because of the thermostatic control and need for even heat distribution. This experience was valuable later since it helped me recognize problems which arose from faulty set-ups."

Another experience was with a steam trap casting which could not leak under pressure. Gas pockets formed during solidification; many could not be seen visually but were detected on testing. Harold and the superintendent worked on ideas to reduce the scrap losses. Six different molds were chosen. Says Harold:

"We were sure that at least one of our six experiments would work, perhaps more. If the latter were the case, we would pick the method which would produce the most castings with consistent quality. Four good castings were produced and two were scrap.

"We made several more runs to find which produced the most consistent good casting. When this was accomplished, we made the modification permanent and put the casting into operation."

Harold also took an active part in the new coreroom addition to the foundry. He reports: "The main benefit I received from this was that of planning improvements which not only made the plant larger but also improved the working efficiency of the foundry."

He was able to put into practice his college welding knowledge in the construction of the new building. Harold reports:

Cites Benefits

"This is only one example of how college and work are beginning to relate to each other. A college lecture on metallurgy is much easier to comprehend if a person has practical experience which he can picture in his mind. On the other hand, a course on the chemical composition of metals enables the student to understand metallurgical problems in the foundry. The practical courses in college, such as welding, enables a person to go back to work and weld as good as men who have welded for years without formal training."

Harold summarizes his experience with cooperative training in this manner:

"I believe that the largest single benefit of the cooperative training program is that it gives you an education that is immediately usable. Unlike many courses where first theory is taught and practical experience is gained afterwards, I feel certain that my college work correlated with the practical experience in industry will give me a better understanding of my responsibilities and become more productive in a shorter period of time."

The foundry and metallurgy technology course at Western Michigan is offered on a two year plan on a full time basis or on a three-year plan on a cooperative basis.

The curriculum is designed to prepare personnel for the foundry industry who for the most part will be employed as laboratory technicians, inspectors, supervisors, and in research and development. Upon completing the foundry and metallurgy technology program, a student may enroll in the engineering technology curriculum for a B.S. degree.

Central Michigan Plan

A $500 annual scholarship fund has been established at Western Michigan University to aid qualified students. It is designed to provide $125 per student for two students each college semester.

Any high school student living in the nine-county area encompassed by the Central Michigan Chapter may apply for the scholarship. They are selected on the basis of academic and extra-curricular records and personal recommendation.

Qualifications for support continuance by a scholarship recipient require that he maintain a 2.5 or C-plus scholastic average. If cooperative training or summer work is involved, entailing foundry industrial employment, the recipient must work for a company which has AFS Central Michigan membership representation.

Harold Clipfell, Three Rivers, Mich., a sophmore at Western Michigan University, under the cooperative plan, operates a shell core machine at Dock Foundry Co.

AFS Chapter Meetings

FEBRUARY

Birmingham District . . *See Southeastern Regional Conference.*

British Columbia . . Feb. 17 . . Lougheed Hotel, Vancouver, B. C. . . Technical Session.

Canton District . . Feb. 2 . . American Legion, Massillon, Ohio . . J. Morgan, Foresco Co., *"Exothermics"*.

Central Illinois . . Feb. 6 . . Vonachen's Junction, Peoria, Ill. . . C. E. Wenninger, Beardsley & Piper, *"Digging Into Sand Fundamentals."*

Central Indiana . . Feb. 6 . . Athenaeum Club, Indianapolis . . G. W. Anselman, Anselman Foundry Services, Inc., *"New European Techniques." Student's Night.*

Central Ohio . . Feb. 13 . . Seneca Hotel, Columbus, Ohio . . J. B. Caine, Foundry Consultant, *"Cast vs Wrought Materials."*

Chesapeake . . Feb. 24 . . Baltimore Engineers Club, Balitimore, Md. . . L. A. Gardner, Pangborn Corp., *"Foundry of Tomorrow."*

Chicago . . Feb. 6 . . Chicago Bar Association, Chicago . . G. Koren, Beardsley & Piper Div. of Pettibone Mulliken Corp., *"Shell Molding and Coring Equipment."*

Cincinnati District . . Feb. 13 . . Eaton Manor, Hamilton, Ohio.

Connecticut . . Feb. 28 . . Waverly Inn, Cheshire, Conn. . . F. Yrigoyen, Curtis-Wright Metals Processing Div., *"Shell Molding & Shell Cores."*

Corn Belt . . Feb. 17 . . Town & Country Restaurant, Lincoln, Neb. . . G. Di Sylvestro, American Colloid Co., *"Veining & Penetration."*

Detroit . . Feb. 16 . . Pontiac Motor Co. Foundry Division, *Tour of Foundry Operations.*

Eastern Canada . . Feb. 10 . . Sheraton Mount-Royal Hotel, Montreal, Que. . . *Past Chairmen's Night.*

Eastern New York . . Feb. 20 . . Panetta's Restaurant, Menands, N. Y., J. H. Schaum, MODERN CASTINGS, "Why Use Metalcastings?"

Metropolitan . . Feb. 6 . . Military Park Hotel, Newark, N. J. . . Old Timers' Night . . C. E. Fausel, Chicago Foundry Co., *"Reduce Downtime Through Preventive Maintenance."*

Michiana . . Feb. 13 . . Club Normandy, Mishawaka, Ind. . . A. B. Sinnett, American Foundrymen's Society, *Talk and Film Plus Presentation to Past Chairman.*

Mid-South . . Feb. 10 . . Hotel Claridge, Memphis, Tenn. . . R. A. Colton, Federated Metals Corp., *"Non-Ferrous Metals."*

Mo-Kan . . Feb. 16 . . Fairfax Airport, Kansas City, Kan. . . D. L. Colwell, Apex Smelting Co. . . *"Melting, Casting and Properties of Aluminum."*

Northeastern Ohio . . Feb. 2 . . Case Institute of Technology . . *"How Foundry Sands Affect Casting Surfaces."* . . **Feb. 4** . . Manger Hotel, Cleveland . . *Ladies Night.*

Northern California . . Feb. 13 . . Spenger's Fish Grotto, Berkeley, Calif., J. H. Kimes, Jr., Tennessee Products Chemical Corp., *"Ductile Iron vs Weldments & Forgings."*

Northern Illinois & Southern Wisconsin . . Feb. 14 . . Frontier Inn, Rockton, Ill. . . D. Matter, Ohio Ferro-Alloys Corp. . . *"Ductile Iron."*

Northwestern Pennsylvania . . Feb. 27 . . Amity Inn, Erie, Pa. . . D. L. La Velle, American Smelting & Refining Co., *"Understanding Mechanical Properties and Diagnosing Rejections."*

Ontario . . Feb. 24 . . Seaway Hotel, Toronto . . D. R. Abbey, *"Safety—Foundry Frills, Fantasies and Facts."* R. E. Crowe, Crowe Foundry Ltd., *"Customer Service."*

Oregon . . Feb. 15 . . Park Heathman Hotel, Portland, Ore.

Philadelphia . . Feb. 10 . . Engineer's Club, Philadelphia . . G. Koren, *"Resin Sand—Shell Cores."*

Pittsburgh . . Feb. 20 . . Hotel Webster Hall, Pittsburgh, Pa. . . G. M. Etherington, American Brake Shoe Co., *"Shell Cores."*

Quad City . . Feb. 20 . . Le Claire Hotel, Moline, Ill. . . G. W. Anselman, Anselman Foundry Services, *"Pneumatic Materials Handling and Its Effect on Molding and Core Sand."*

Rochester . . Feb. 13 . . Chamber of Commerce, Rochester, N. Y. . . *Joint Meeting A. S. M.*

Saginaw Valley . . Feb. 2 . . Fischer's Hotel, Frankenmuth, Mich. . . R. Simon, Saginaw Malleable Iron Co. and J. Didrer, Chevrolet Saginaw Grey Iron Foundry, *"Application of Plastic Materials in the Foundry."*

St. Louis District . . Feb. 9 . . Edmonds Restaurant, St. Louis . . H. P. Stephenson, Pittsburgh Metals Purifying Co., Inc., *"Exothermics For All Metals."*

Southeastern Regional Conference . . Feb. 16-17 . . Read House, Chattanooga, Tenn. Sponsored by Tennessee and Birmingham Chapters, and University of Alabama Student Chapter.

Southern California . . Feb. 10 . . Rodger Young Auditorium, Los Angeles . . J. Marden, Eutectic Welding Alloy Corp., *"New Welding Procedures."*

Tennessee . . *See Southeastern Regional Conference.*

Texas . . Feb. 10 . . Texas A & M Memorial Student Center, College Station, Texas . . W. C. Jeffery, Mc Wane Cast Iron Pipe Co., *"Career Opportunities in the Cast Metals Industry.*

Timberline . . Feb. 15 . . Oxford Hotel, Denver, Colo. . . D. L. Colwell, Apex Smelting Co., *"Melting, Casting & Properties of Aluminum."*

Toledo . . Feb. 1 . . Heatherdowns Country Club, Toledo, Ohio . . G. L. Miklos, Western Electric Co., *"Quality Control."*

Tri-State . . Feb. 10 . . Ramada Inn, Tulsa, Okla. . . J. R. Speer, Texas Foundries, Inc., *"Quality Control In The Foundry."*

Twin City . . Feb. 14 . . Jax Cafe, Minneapolis . . T. E. Barlow, International Minerals & Chemical Corp., *"Cupola Practice."*

Utah . . Feb. 11 . . *Valentine Party.*

Western Michigan . . Mar. 6. Bill Stern's, Muskegon, Mich. . . *Plant Visitation, West Michigan Steel.*

Western New York . . Feb. 3 . . Sheraton Hotel, Buffalo, N. Y. . . T. E. Barlow, International Minerals & Chemical Co., *"How To Louse Up A Cupola."*

Wisconsin Regional Conference . . Feb. 9-10 . . Hotel Schroeder, Milwaukee. Sponsored by Wisconsin Chapter and University of Wisconsin.

MARCH

Toledo . . Mar. 1 . . Heatherdowns Country Club, Toledo, Ohio . . R. Cochran, R. Laven & Sons, Inc., *"Non-Ferrous Melting Practice."* Philip R. Kaliscger, Precision Metal Molding, *"Aluminum as it Affects Permanent Mold and Die Castings in Automotive Industry."*

Canton District . . Mar. 2 . . Town & Country Restaurant, Canton, Ohio . . J. F. Wallace, Case Institute of Technology, *"Gating and Risering of Gray Iron."*

Piedmont . . Mar. 3 . . Hotel Barringer, Charlotte, N. C. . . C. H. Palmer, Newego Engineering Co., *"Small Foundry Mechanization."*

Western New York . . Mar. 3 . . Hotel Sheraton, Buffalo, N. Y. . . H. J. Weber, American Foundrymen's Society, *"How AFS Can Save You Money on Air Pollution, Ventilation, and Noise Problems."*

Future Meetings and Exhibits

Feb. 9-10 . . AFS Wisconsin Regional Foundry Conference. Schroeder Hotel, Milwaukee.

Feb. 14-17 . . National Metallurgical Laboratory, Symposium "Light Metal Industry in India," Auditorium, National Metallurgical Laboratory, Jamshedpur, India.

Feb. 16-17 . . AFS Southeastern Regional Foundry Conference. Read House, Chattanooga, Tenn.

Feb. 22-24 . . Material Handling Institute, Pacific Coast Show. Cow Palace, San Francisco.

Feb. 22-24 . . Alloy Casting Institute Midwinter Management Meeting, Boca Raton, Fla.

Feb. 26-March 2 . . American Institute of Mining, Metallurgical & Petroleum Engineers, Annual Meeting. Ambassador and Chase-Park Plaza Hotels, St. Louis.

March 1-2 . . Malleable Founders Society, Technical & Operating Conference. Pick Carter Hotel, Cleveland.

March 5-9 . . American Society of Mechanical Engineers, Gas Turbine Conference & Exhibit, Shoreham Hotel, Washington, D. C.

March 11-14 . . Steel Founders' Society of America, Annual Meeting. Drake Hotel, Chicago.

March 20-24 . . American Society for Metals, Western Metal Exposition & Congress, Pan-Pacific Auditorium, Los Angeles.

March 21-30 . . American Chemical Society, Spring Meeting. St. Louis.

April 10-12 . . American Institute of Mining, Metallurgical & Petroleum Engineers, Open Hearth Steel Conference. Sheraton Hotel, Philadelphia.

April 12-14 . . American Institute of Mining, Metallurgical and Petroleum Engineers, International Symposium of Agglomeration, Sheraton Hotel, Philadelphia, Pa.

April 18-20 . . Foundry Educational Foundation, Annual College-Industry Conference. Statler-Hilton Hotel, Cleveland.

April 18-20 . . American Welding Society, Annual Meeting and Welding Show. Commodore Hotel and Coliseum, New York.

May 8-12 . . AFS 65th Castings Congress, Civic Auditorium, San Francisco.

May 9-11 . . Material Handling Institute, Eastern States Show. Convention Hall, Philadelphia.

May 10-12 . . National Industrial Sand Association, Annual Meeting. The Homestead, Hot Springs, Va.

May 22-25 . . American Society of Mechanical Engineers, Conference and Design Engineering Show, Cobo Hall, Detroit.

May 22-26 . . American Society of Tool and Manufacturing Engineers. Engineering Conference and Exhibit, New York City.

June 8-9 . . Malleable Founders Society, Annual Meeting. The Broadmoor, Colorado Springs, Colo.

June 15-16 . . AFS Chapter Officers Conference. LaSalle Hotel, Chicago.

June 18-20 . . Alloy Casting Institute, Annual Meeting, Hot Springs, Va.

June 18-24 . . 28th International Foundry Congress, Vienna Imperial Castle, Vienna, Austria.

June 22-24 . . AFS Penn State Regional Foundry Conference. Penn State University, University Park, Pa.

June 25-30 . . American Society for Testing Materials, Annual Meeting. Chalfonte Haddon Hall, Atlantic City, N. J.

Sept. 3-8 . . American Chemical Society, Fall Meeting. Chicago.

Sept. 20-23 . . American Ceramic Society, Enamel Division, French Lick-Sheraton Hotel, French Lick, Ind.

Sept. 24-26 . . Steel Founders' Society of America, Fall Meeting. The Homestead, Hot Springs, Va.

Oct. 16-21 . . National Industrial Sand Association, Semi-Annual Meeting. The Greenbrier, White Sulphur Springs, W. Va.

Oct. 18-20 . . Gray Iron Founders' Society, Annual Meeting. Royal York Hotel, Toronto, Ont.

Oct. 19-21 . . Foundry Equipment Manufacturers Assn., Annual Meeting. The Greenbrier, White Sulphur Springs, W. Va.

Oct. 23-27 . . American Society for Metals, Detroit Metal Show (43rd National Metal Congress and Exposition), Cobo Hall, Detroit, Mich.

Nov. 13-15 . . Steel Founders' Society of America, Technical & Operating Conference. Pick Carter Hotel, Cleveland.

Nov. 15-17 . . National Foundry Association, Annual Meeting. Savoy-Hilton Hotel, New York.

Foundry Trade News

Barker Foundry Supply Co. . . . Los Angeles, named manufacturers representative for WaiMet Alloys Co., Dearborn.

American Steel Foundries . . . Chicago, has started construction of a steel pipe coating and wrapping plant in Youngstown, Ohio to be operated by their subsidiary; Pipe Line Service Corporation. The 94,000 square foot plant will be the eighth pipe coating plant operated by the company.

General Refractories Co. . . . Philadelphia, has named Sussman Asbestos Co. as Toledo distributor for their products.

Budd Co. . . . Philadelphia, has changed both name and address of its Canadian subsidiary. Formerly called Tatnall Measuring & Nuclear Systems, Ltd. and located in Toronto, the division, moved to Ontario, will be called Budd Instruments, Ltd.

Dow Chemical Co. . . . has announced plans to close the die casting department of its Bay City, Michigan plant. Two reasons were cited for the move: 1) Dow will no longer be in competition with other die casters who are its customers for magnesium die casting ingot; and, 2) the establishment of a customer service laboratory for die casters has eliminated the need to use the plant for development and pilot plant work.

Darling Valve & Mfg. Co. . . . Williamsport, Pa., has recently put into operation a newly equipped bronze foundry with a melting capacity of 12,000 lbs. per day, double that of the old foundry. The modernized foundry can handle up to 1000-pound castings. It is now producing valve parts, such as seat rings, stems, bodies sleeve bearings, disk rings, solid disks, wedging mechanisms, yoke stems and clamp nuts.

United Sheet Metal Co. . . . Columbus, Ohio, has purchased the business of Biggs Steel Foundry & Fabricating Co., including plant, equipment inventory and work in progress, for an announced purchased price of $257,000. The Biggs plant fabricates a wide variety of industrial components, including heat exchangers, pressure vessels, storage tanks, vulcanizers and equipment used in the paper industry. The plant, located in Akron, has approximately 130,000 square feet of floor area on 7-1/2 acres of property.

International Nickel Co. . . . New York, in its development and research division, has established a new tech-

Superior Foundry, Inc., Cleveland, recently won top honors in the annual greater Cleveland industrial safety campaign. Superior Foundry operated throughout the second quarter of the year without a lost time accident.

Al Hunt, Superior Foundry Executive Vice-President, and AFS Vice-President, reads the citation to the plant's safety committee. Standing are James Knize, Jesse Payne, Willie Williams, William Nowak, and Al McLaughlin. Seated are Jim Sims, Al Hunt, Leroy Payne, and Harold Wheeler. Missing from photo is nurse Betty Shroyer, also a committee member.

nical service which will deal with nickel alloys at elevated temperatures. This new high temperature engineering section will serve industry on all problems arising in the use of materials in environments at elevated temperatures.

Techno Fund, Inc. . . . Columbus, Ohio, has acquired interest of the Taccone molding machine and other products in the line.

Woodruff & Edwards, Inc. . . . Elgin, Ill., sold four divisions to Gerald Ruttenberg, owner, Josam Mfg. Co., Michigan City, Ind. Ruttenberg sold two of the divisions, the foundry and machine shop in Elgin, to Woodruff & Edwards employees. A. Gordon Heitman is president of the new corporation which retains the name Woodruff & Edwards.

Malleable Founders Society . . . is again conducting a redesign contest for member companies. Prizes will be awarded on the basis of design problems solved, significance of the conversion to industry cost savings and other services to the customer. Personnel of all of the Society's 46 member companies are eligible. There will be five prizes given starting at $100. Deadline for entries is March 1, 1961.

Crucible Steel Co. of America . . . Pittsburgh, through its wholly owned subsidiary, World Crucible Ltd., has established an Australian company, Crucible Steel Australia Pty. Ltd. The new company will distribute a full line of specialty steel products of Crucible Steel of Canada and the American company.

Gray Iron Founders' Society . . . has given official recognition to ductile iron castings and will promote the use of both ductile and gray iron castings. Members of the newly formed ductile iron committee are: John W. Perry, Jr., Grede Foundries, Inc., Milwaukee; Hermann P. Good, Foundry Div., Textile Machine Works, Reading, Pa.; Edward L. Roth, Motor Castings Co., West Allis, Wis.; Robert W. Jordon, Hamilton Foundry, Inc., Hamilton, Ohio; George H. Tomkins, Black-Clawson Co., Hamilton, Ohio; and Charles A. Glenn, Lynchburg Foundry Co., Lynchburg, Va.

Safety Binders . . . .
with modern castings

®MODERN CASTINGS 1961

New Books for You . . .

Silicon and its Binary Systems. A. S. Berezhnoi. 256 pages. Consultants Bureau Enterprises, Inc., 227 West 17th St., New York 11. 1960. A critical review of data accumulated on the physical chemistry of silicon and its binary systems. Properties and descriptions of the crystal structures are presented in detail, and important applications are given. In the first part, methods for producing silicon are set down plus its purification, and methods for preparing binary compounds of silicon. Some 164 silicides and their principal characteristics are listed.

Successful Managerial Control by Ratio-Analysis. Spencer A. Tucker. 436 pages. McGraw-Hill Book Co., 330 West 42nd St., New York 36. 1961. Company data and statistics can be reduced to significant mathematical ratios in this system of control. Book shows how to interrelate these ratios to provide managers with tools for evaluation, decision-making, remedial action and long-range planning. The book describes how a manager can cope with a myriad of facts, events, and changes. Information and data are drawn from three major segments of industrial activity, namely; production, sales, and finance. Over 400 specific ratios are given and details are presented for using the most important of these, as well as for developing others to use in specific areas.

Welding Metallurgy. 122 pages. American Welding Society, 33 West 39th St., New York 18. 1960. The pocket-size booklet on ferrous and non-ferous welding metallurgy has been prepared and reviewed by leading metallurgists in the United States. It is a condensation of the latest edition of the Welding Handbook. The comprehensive text covers temperature changes in welding, structure of metals, mechanical properties of metals, factors influencing metal properties, fractures in metals, factors affecting weldability, plain steel, and low and high-alloy steels, nickel, copper, aluminum magnesium, titanium and alloys of each.

Let's Get Personal . . .

Fred J. Pfarr . . . former AFS National Director, is now sales representative for Hines Flask Co., Cleveland.

Floyd B. Parker . . . is now staff specialist, American Radiator & Standard Sanitary Corp., Baltimore, Md., coordinating enameling operations of the company's foundries.

James J. Schwalm . . . is now foundry sales manager, Archer-Daniels-Midland Co., Cleveland. He is First Vice-Chairman of the AFS Northeastern Ohio Chapter. Other appointments: **William T. Ellison** to assistant foundry sales manager; **Guy Wolcott,** sales representative in the Tri-City area: **Arthur Penters,** sales representative in the Milwaukee area; **J. Alex Dunn,** sales representative in Western Michigan area.

John E. Gotheridge . . . named eastern regional sales manager, Foundry Services, Inc., of Cleveland.

Philip A. Gaebe . . . is product manager, refractories, Kaiser Refractories & Chemicals Div., Kaiser Aluminum & Chemicals Sales, Inc. Other appointments: **Harold B. Davidson,** to assistant to the general manager at Pittsburgh, Pa.; **A. S. Arcari** to manager of sales service for the eastern division.

A. Kemp Stevens . . . is New England sales manager, Hartford, Conn., for Wellman Bronze & Aluminum Co., Cleveland. **William F. Trakat, Jr.,** is in charge of sales for the eastern area with office at Lansdale, Pa.

Robert F. Cox . . . is sales engineer, Pangborn Corp., Hagerstown, Md.

R. O. Tibbals . . . works manager of the Granite City, Ill., plant of Transportation Equipment Div., American Steel Foundries, is now the firm's vice-president for manufacturing. **A. P. Steinhauser** succeeds Tibbals.

Russell Plum . . . is now plant manager, Keokuk Steel Castings Co., Keokuk, Iowa. **John Strohmaier** is now superintendent.

Jerry Grott . . . presently manufacturing manager, Waimet Alloys Co., Dearborn, Mich., assumes additional duties as technical manager. **John Fritz,** materials manager, will also assume duties of assistant manufacturing manager, and **George Haley** becomes supervisor, quality control.

John J. Keane . . . and **Willem F. H. Borman** have been appointed to the chemical development operation of General Electric's chemical and metallurgical division, Pittsfield, Mass.

William J. Grede . . . elected chairman of the board of the J. I. Case Co., Racine, Wis. **John T. Brown,** who resigned as chairman, was elected vice chairman of the board and will serve as special assistant to the president.

John R. Ikner . . . has been appointed plant manager of Chevrolet Motor Division's gray iron foundry in Saginaw, Mich., succeeding the late **William C. Schartow.**

Donald Alford . . . was appointed office manager of Eastern Malleable Iron Co., Wilmington, Del. **Vincent Neville** was appointed purchasing agent.

Floyd B. Parker . . . made staff specialist, coordinating cleaning and enameling operations for the foundries of American Standard Corp., with headquarters in Baltimore.

Charles Walter . . . appointed sales representative for the Foundry Div., DeLaval Steam Turbine Co., Trenton, N. J.

Vincent Tripodi . . . transferred to Dodge Steel Co., Philadelphia as metallurgist.

R. O. Tibbals . . . appointed vice-president of manufacturing for the Granite City, Ohio, plant of Transportation Equipment Div., American Steel Foundries.

David W. Boyd . . . named executive vice president of Engineering Castings, Inc., Marshall, Mich. **J. Raymond Mohlie** has been named vice president and general manager of the firm.

Stanley B. White . . . is vice president, manufacturing, aluminum, for Kaiser Aluminum & Chemical Corp., Oakland, Calif.

W. O. Dick . . . named vice president and general manager of Canton Malleable Iron Co., Canton, Ohio, subsidiary of Penn Machine Co., Pittsburgh.

Edgar W. Bliek . . . was named division manager of the Foundry and Metallurgy Div., Gleason Works, Rochester, N. Y. Two other appointments at the firm are **Alfred J. Murrer,** manager, machine division, and **Donald L. Whitmore,** manager of Gleason's plant in Watford, England.

Ralph D. Brizzolara . . . has retired as vice president of American Steel Foundries, Chicago, after 41 years of service.

Arthur G. Witt . . . has been appointed general sales manager of the Cleveland division of Precision Castings Co.

obituaries

Martin Manion, executive vice-president, Centre Foundry & Machine Co., Wheeling, W. Va. He was active in affairs of the Gray Iron Founders' Society.

Walter Giele, Walter S. Giele Co., Lebanon, Pa., former chairman of the Philadelphia Chapter and long active in its activities.

Arnold J. Salg, Sr., who had been active in the foundry industry for 54 years, retiring in 1958. He started as a molder's apprentice at the age of 14 and had been foundry superintendent at plants in Missouri, Michigan, Colorado, Wisconsin, and Minnesota.

Alfred C. Barbour, 69, president and board chairman of Roessing Bronze Co., Pittsburgh, Pa.

George Arents, 85, founder of the American Machine & Foundry Co. in 1900.

Edward Fletcher Rigg, assistant secretary and treasurer, United Engineering & Foundry Co., Wilmington, Dela.

A. G. Ealy, Vice-President, Littlestown Hardware & Foundry Co., Littlestown, Pa.

Mrs. Leila Wright Pekor, 92, widow of the late Charles F. Pekor and president of Pekor Iron Works, Columbus, Ga.

New Products and Processes

What's new in foundry methods and equipment? Summaries of many are presented below. Circle corresponding number on free postcard, page 145. Mail it to us; we'll do the rest!

Fixtures, Accessories Double Casting Drilling Operations

A fixture holding two parts instead of one, plus pneumatic feed and four-speed spindle multiple-head on standard drill press, has more than doubled rate of drilling two holes in camera parts casting.

Operator in one motion picks up and positions two castings in the fixture, actuates foot pedal, removes castings and substitutes another pair in less than 20 seconds. Rockwell Mfg. Co.

Circle No. 1, Pages 145-146

Car-Type Oven Processes 300-Ton Load for Foundry in Pennsylvania

Car-type oven, processes a 300-ton load at temperature up to 800 F. in Pennsylvania foundry. Believed to be the largest of its kind in the world, the combination gas and oil fired recirculating air heating system provides ten million BTUs per hour. The door opening is 16 feet wide and 18 feet high with a useful inside work space of 11,000 cubic feet. Both the heavy-duty, sub-floor car moving system and the doors at each end of the oven are push-button controlled. Coleman Co.

Circle No. 2, Pages 145-146

New Ultrasonic Flaw Detector Features Increased Accuracy

Equipped with a newly developed caliper attachment, ultrasonic flaw detector may be used to measure thickness of metals and plastics, from one side, to accuracies within plus or minus 0.010 inch.

Operation of caliper consists of fixed, scribed, vertical line, and a second line on a slider, movable across face of cathode ray tube. Synchronized dial indicator measures amount of motion, permitting operator to determine thickness directly, with calculation or interpolation. Although pulse-echo equipment is principally used to ascertain presence of hidden discontinuities, voids, slag inclusions and serve porosity, new accessory permits accurate location of these and similar flaws. Branson Instruments, Inc.

Circle No. 3, Pages 145-146

High Production Wet Blaster Replaces Many Hand Operations

High production wet blaster can be used to replace hand operations such as cleaning, de-burring or de-scaling hard-to-reach areas.

Featuring stainless steel construction, pull-push controls, indicating lights and other highlights, unit provides reliable performance since pumps and moving parts have been eliminated from the blast-circuit. Hydra & Power Blast Mfg. Div., Automation Services, Inc.

Circle No. 4, Pages 145-146

Powder Lance Eliminates Noise In Demolishing Concrete Walls

Powder lance burns through concrete without noise or vibration. Mixture of oxygen and metallic powder produces extremely high temperature reaction, melting concrete and other ferrous and non-ferrous materials. Linde Co., Div., Union Carbide Corp.

Circle No. 5, Pages 145-146

Two Lubricants Aid in Improved Die Casting Surface Finish

Achieving a micro-smooth surface finish in gravity die casting with aluminum alloys has been accomplished by Akron Die Casting Co. Process is used in casting missile and aircraft valves, high pressure fittings, aircraft accumulators, aircraft wheels, pump bodies, tire mold dies, small cylinder heads and outboard motor parts.

Process consists of tipping casting machine to pour any standard aluminum alloy into cavity. When the cavity is filled, machine returns to rest position and the casting removed. Firm coats die cavities with two lubricants, one a dispersion of colloidal graphite in water and other is a dispersion of vermiculite in water. Acheson Colloids Co.

Circle No. 6, Pages 145-146

Controlled-Atmosphere Furnace Treats Missile, Rocket Cases

Controlled-atmosphere, bottom quench, gantry furnace for heat treating missile and rocket motor cases and other metal components has been placed in operation at company's Los Angeles plant.

Air Force certified, the new furnace is electrically heated. Using staurable core reactors, it has three control zones of 115 KW each, and operates between 250 and 2050 F. Lindberg Steel Treating Co.

Circle No. 7, Pages 145-146

Automatic Centrifugal Casting Machine Increases Production

Some advantages of centrifugal casting system and machines are pointed out by company. Claims advanced include: (a) Lighter castings can be produced than by conventional machines; (b) Machines give higher production with less manpower; (c) Castings produced are of better quality, than those produced by present methods, since there is practically no turbulence in the die during the spinning operation.

Units are automatic. Only operation carried out by the attendant is pouring molten metal into the crucible and switching it on. F. E. (North America) Ltd.

Circle No. 8, Pages 145-146

Rotary Shotblast Table Employs Impellers for Cleaning Action

Rotary shotblast tables require no compressed air. They are self-contained units which can be used where surfaces of castings or other metal articles have to be cleaned or roughened.

Principal structural parts are rotary fettling tables and high duty impeller system. Throughout of shot per impeller ranges from 66-132

pounds per minute. Impellers are so arranged that work pieces lying on the table are subjected as uniformly as possible to impact of the shot. Conveyor & Shotblast Ltd.

Circle No. 9, Pages 145-146

Temperature Measuring Unit Operates On Solids

Units for accurate temperature regulation are operated through variation in expansion of different solids. Controls use sturdy tube of one metal plus inner tube or rod of another material.

As temperature increases, outer tube expands at greater rate than inner tube or rod. Since tube is fixed to instrument head, difference in expansion rate causes inner member to move relative to instrument head, allowing lever to move down. This actuates a micro switch, cutting off heat. On a temperature drop reverse is true. Burling Instruments Co.

Circle No. 10, Pages 145-146

Automatic Zinc Die Cast Machine Features Improved Controls

Fully automatic zinc die casting machine features new, ultra-sensitive pressure switch with infinite adjustment, in series with a wide tolerance micro-switch. Unit feels foreign matter flash or a stuck casting between dies as they lock up.

Any unejected casting or foreign matter causes die to retract and stop cycle. DCMT Sales Corp.

Circle No. 11, Pages 145-146

High Temperature Parting Agent Avoids Build-Up on Cores, Boxes

Foundry parting agent, effective for parting urea cores made in dielectric furnaces from the core boxes, withstands high temperatures which allows effective parting. Applied from an aerosol spray container, submicron particle sizes of the material avoids build up on cores or core boxes. Allaco Products.

Circle No. 12, Pages 145-146

Rubber-Tired Tractor Shovels Help Solve Spillage Problem

To help solve the problem of spillage of bulk materials during transportation within the plant, firm has developed rubber-tired, tractor-shovels with 2000, 2500 and 3000-pound operating capacities.

Side sheets of the new buckets on units are curved to conform to an arc traveled by a combination striker-bar-spillguard. Device hydraulically moves through arc from top side of back of bucket to front and removes excess material. Frank G. Hough Co.

Circle No. 13, Pages 145-146

Car Shaker Expedites Unloading of Solidly Packed Materials

Car shaker expedites unloading of heavy, solidly packed materials from open top hopper bottom railroad cars. Shaker imparts a heavy impact to top of car side, together with a powerful blow against car side just over pockets. These rapid, strong blows at pockets speed flow of material from car.

For a rapid discharge of stubborn materials, two shakers may be used, one at each end of car on same side or on opposite sides. Eastern Constructors, Inc.

Circle No. 14, Pages 145-146

Integrated Shell Sand Coating Plant Is Easily Installed

New shell sand coating plant for resin coating sand to be used in making shell cores for shell molds is available.

Auxiliary and control equipment is integrated and mounted on a heavy steel bed. Plant is completely wired and piped. At installation, requires only connecting air lines and electric power to the control panel. Shalco Div., National Acme.

Circle No. 15, Pages 145-146

Compound Cuts Grain Size, Increases Structural Strength in Aluminum

Metallurgical compound reduces grain size and increases structural strength in aluminum and aluminum-alloy castings. Available in five grades for treatment of various alloys, and as tablets or blocks.

In addition to improving metal strength, compound enhances feeding properties of melt, increases resistance to hot tearing, and reduces or eliminates homogenizing. Foundry Services, Inc.

Circle No. 16, Pages 145-146

Heavy-Duty Industrial X-Ray Unit Features Unusual Sharpness

Heavy-duty industrial x-ray machine that produces images of "unmatched sharpness" for testing and inspection has been developed. Sharper x-ray pictures are made possible by tube's 0.012-inch focal spot, smallest of any x-ray unit.

Unit has a rotating anode tube with a continuous rating of 6 milliamperes at 150 kilovolts, twice the output of a stationary anode tube. Machine can reveal very small defects and is especially suited for industries requiring large amounts of non-destructive inspection. Picker X-Ray Corp.

Circle No. 17, Pages 145-146

Flourspar Briquettes Permit Better Control of Additions

Flourspar in briquette form permits treating material as a carefully controlled part of charge rather than a haphazard addition of a variable quantity occasioned by necessity for shovelling.

This reducing of variables to an absolute minimum prevents costly mistakes such as off-chemistry heats in steel making. Each briquette guaranteed to be at least 95 per cent units of purity. Main feature of flourspar in briquette form is convenience of receiving and handling material in mills. Most important advantage of the product is that it is "acid grade" (minimum 95% effective CaF_2) compared to conventional metallurgical grade (approximately 72% effective CaF_2). Glen-Gery Shale Brick Corp.

Circle No, 18, Pages 145-146

Simple Changes Quickly Adapt Machine for Various Tests

All materials such as metal, plastics, wire, etc., can be easily tested. Simple changes in grips quickly adapts basic instrument for tests of tensile, compression, transverse and shear forces.

Operation is by a calibrated pendulum. Guaranteed accurate within 1/2 of 1% of indicated reading in accordance with A.S.T.M. requirements. W. C. Dillon & Co.

Circle No. 19, Pages 145-146

Easily Adjustable Manhole Frame Eliminates Many Costly Operations

New manhole frame has six-inch vertical adjustment, eliminating reset costs, shimming, and paved-over manhole covers. The frame conforms to crown and grade simultaneous and is adjusted by one man in minutes. Unit has infinite adjustment from 0 to six inches. Foundry inquiries for manufacturing are invited. Adjusta-A-Frame Corp.

Circle No. 20, Pages 145-146

For The Asking

Build an idea file for improvement and profit. Circle numbers on literature request card, page 145, for manufacturers' publications.

Aluminum products for deoxidizing molten steel . . . are described in this 4-page folder. Products include bars which are castings of metallurgical aluminum to be wedged on the end of a long steel rod and plunged into the molten steel bath in either furnace or ladles. Brown Aluminum & Chemical Co.

Circle No. 49, Pages 145-146

Reducing impact shock . . . Booklet describes resilient material, Fabreeka, which absorbs vibration from machines such as jolt molders, tumbling barrels and shakeout machines. Fabreeka Products Co.

Circle No. 50, Pages 145-146

Dust collector . . . wet, inertial unit, collects over 99 per cent of all dust particles 5 microns and larger, 92 per cent of 2-micron dust, and substantial amounts of smaller dust. Twelve-page catalog shows typical applications, charts, and graphs. Western Precipitation Div., Joy Mfg. Co.

Circle No. 51, Pages 145-146

Sensater hydraulic crane . . . operates under extreme conditions such as dust, grit, moisture, corrosion, and impact. Operations of unit and typical installations are contained in 4-p catalog. Martin Decker Co.

Circle No. 52, Pages 145-146

Uses for mischmetal in ductile iron . . . bibliography, contains 27 recent references. Cerium Metals & Alloys Div., Ronson Metals Corp.

Circle No. 53, Pages 145-146

Shaft mounted and flange mounted drives . . . bulletin, 36 pp, includes new series of drives covering a range up to 44,000 lb/in., and new dimensional data and engineering drawings. Falk Corp.

Circle No. 54, Pages 145-146

CO_2 fire fighting equipment . . . for metal working industry booklet describes low-pressure carbon dioxide storage units, facilities for service and supply of carbon dioxide, and high-pressure systems for smaller capacity needs. Describes three methods of application, direct, total flooding, and hose reels. Cardox Div., Chemetron Corp.

Circle No. 55, Pages 145-146

Industrial safety equipment . . . catalog data on safety hooks, safety insulated hooks, mechanical back-up alarms, safety truck steps, and auto safety belts. Universal Safety Equipment Co.

Circle No. 56, Pages 145-146

Vacuum spectrometer . . . yields over 1000 determinations in continuous 8-hour operation and may be handled by regular laboratory personnel. Gives simultaneous quantitative results for all important elements including phosphorus, sulfur, and carbon in less than 2 minutes. Four-page booklet shows cut-away drawings and operating features. Applied Research Laboratories.

Circle No. 57, Pages 145-146

Cost-cutting materials handling . . . ideas are compiled in 80-p handbook. Covers pros and cons on various types, specials versus standard trucks, pallet versus palletless handling, and how to select the right truck for the right job. Automatic Transportation Co., Div. Yale & Towne Mfg. Co.

Circle No. 58, Pages 145-146

Magnet drum separators . . . wet, permanent type features non-magnetic, corrosion-proof, stainless steel for feed box collection tank and a special wear-resistant cylinder material. Bulletin contains specifications and dimensions of all sizes. Stearns Magnetic Products Co.

Circle No. 59, Pages 145-146

Drill press equipment . . . Catalog describes the light-heavyweight 17-in. equipment line. Includes illustrations, specification data, charts, and tables. Instructions given for selecting var-

ious models to suit a wide range of job requirements. Walker-Turner Div., Rockwell Mfg. Co.

Circle No. 60, Pages 145-146

Safety tape . . . guards fingers, wrist, and lower forearms from sparks, cuts, and puncture wounds during grinding operations. General Bandages, Inc.

Circle No. 61, Pages 145-146

Gearmotors and coupled speed reducers . . . motorized drives for cranes, elevators, fans, machine tools, punch presses, etc. are discussed. Included are detailed charts showing type of motor needed for specific jobs. Howell Electric Motors Co.

Circle No. 62, Pages 145-146

Belts . . . a detailed eight-page bulletin describes design features and performance advantages of new belts for heavy and light duty, short and long center applications. Manhattan Rubber Div., Raybestos-Manhattan Co.

Circle No. 63, Pages 145-146

Blast cleaning equipment . . . is described and illustrated. In addition to photographs and cut-away diagrams, the bulletin gives complete dimensions and specifications of eight table-rooms, including the twin-table type, showing how each may be tailored to particular requirements. Pangborn Corp.

Circle No. 64, Pages 145-146

Fume reducing . . . four-page booklet presents 11 case histories of typical exhaust purifier installations on industrial vehicles in varied industries. Oxy-Catalyst, Inc.

Circle No. 65, Pages 145-146

Box Furnaces . . . newest models feature heating versatility and increased high-quality production. Control panel is pictured with cut-away drawing. General Electric Co.

Circle No. 66, Pages 145-146

Metallurgical apparatus . . . illustrates and describes such popular laboratory machines as cutters, grinders, mounting presses, portable and table mounted polishers, electrolytic etchers and cleaners. Buehler, Ltd.

Circle No. 67, Pages 145-146

Molecular bonding . . . brochure on basic technical process information, includes information on mechanical properties, thermal properties, effects on steels, and design considerations. Al-Fin Corp.

Circle No. 68, Pages 145-146

Aluminum ingot . . . advantages to be gained through use of better quality ingot are presented in this 12-page brochure. Based on a recently completed quality control program data includes revised terminology, tabular information on composition, suggested uses, properties and recommended thermal treatment of alloys. Aluminum Co. of America

Circle No. 69, Pages 145-146

Mold erosion . . . is discussed in a newsletter. American Colloid Co.

Circle No. 70, Pages 145-146

Conveyors . . . bulletin explores materials handling with an eye toward cost-cutting. Points out 18 ways to cut costs and shows photographs of actual installations with information on equipment used. Shows how cartons can be accumulated on the line without build-up of line pressure and how all sizes and weights can be transported without loss or damage. Rapids-Standard Co.

Circle No. 71, Pages 145-146

High speed steel . . . complete information on a new high speed steel used in high temperature alloys and high strength steels is available in a bulletin describing what is reportedly the hardest grade of high speed steel perfected to date. Shows how significant cost reductions may be obtained in proper applications. Braeburn Alloy Steel Corp.

Circle No. 72, Pages 145-146

Investment castings . . . report presented before the European Investment Casters Ass'n. is available in booklet form. Such subjects as American investment casting industry statistics and important developments in investment casting alloys, are discussed. Report also covers the future for investment castings in the automotive gas turbine engine market, trends in use of castings in American aviation and other allied topics. WaiMet Alloys Co.

Circle No. 73, Pages 145-146

Custom alloy steel castings . . . catalog contains technical data on heat, corrosion, and abrasion resistant alloy steels. Charts listing nearly half of the more than 100 available cast alloys are included as well as descriptions of services and casting methods. Esco Corp.

Circle No. 74, Pages 145-146

Diesel engines . . . recently introduced, are explained in 8-p catalog. Includes performance curves and charts, illustrations, and cut-aways of important components of these 100-210 hp class. Allis-Chalmers Mfg. Co.

Circle No. 75, Pages 145-146

Aluminum alloys . . . that develop superior mechanical properties without heat treatment are described in detail. Material is said to possess excellent machinability. Features include chemical composition, physical properties, plaster and permanent mold characteristics of the material. Apex Smelting Co.

Circle No. 76, Pages 145-146

Air control valves . . . are the subject of a quick reference specification catalog available now. Design characteristics of both manual and mechanical valves are presented along with all standard accessories and their uses. Hoffman Valves, Inc.

Circle No. 77, Pages 145-146

Laboratory flotation machine . . . may be used for agitation, aeration, and attrition scrubbing in addition to floatation process testing. Brochure describes two models. Denver Equipment Co.

Circle No. 78, Pages 145-146

Conduction-type drum cooler . . . handles fine materials at high temperatures, such as foundry sand and cools them rapidly. Large amount of conduction cooling requires relatively

Advertised Products February—1961

Page Numbers

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Advertised Products February—1961

Page Numbers

short time in drum. Bulletin covers operating principles. Link-Belt Co.

Circle No. 79, Pages 145-146

Self-aging aluminum alloy . . . with mechanical properties equivalent to heat-treated alloys are described. Brochure lists specifications and nominal composition, tabulates physical and mechanical properties and gives details of casting methods, dimensional stability, corrosion resistance, machinability and welding, brazing and plating techniques. American Smelting & Refining Co.

Circle No. 80, Pages 145-146

Grinding wheel standards . . . for shapes and sizes have been approved by the American Standards Association. New standards classify, according to 12 end use categories, the shapes and sizes of grinding wheels which are considered standard by industry. Grinding Wheel Institute.

Circle No. 81, Pages 145-146

High-temperature box furnaces . . . with molybdenum resistors, operate at 2300 F. or 3200 F. Four-page bulletin describes construction features and drawings explain insulation system in both models. General Electric Co.

Circle No. 82, Pages 145-146

Briquetting presses . . . convert chips, turnings, and borings into high grade scrap. Produces up to 9 tons per hour into dense cylindrical briquetts which can be charged directly into cupola. Bulletin shows various capacities of six models. Milwaukee Foundry Equipment Div., SPO, Inc.

Circle No. 83, Pages 145-146

Convertible band saw . . . can be used as horizontal cut-off saw or as upright band saw for cutting angles, slots, notches, and bevels. Optional wheels give complete mobility. Bulletin covers descriptive details. Wells Mfg. Corp.

Circle No. 84, Pages 145-146

Aftercoolers . . . for small or medium sized compressed air systems separates moisture by gravity to float trap where it is automatically ejected. Offered with optional automatic cooling water shut-off and in horizontal design for overhead lines. Bulletin describes and illustrates both types. Jas. A. Murphy & Co.

Circle No. 85, Pages 145-146

Handling bulk materials . . . by means of bucket elevators is described in a 22-page booklet. Engineering data on various types of bucket elevators and recommendations on grades of belting for materials of different weights, abrasiveness and temperature are given. Tables on steel elevator buckets, trouble shooting and belt splicing and a glossary of bucket elevator terms, are also included. Hewitt-Robins, Inc.

Circle No. 86, Pages 145-146

Fasteners . . . three data sheets are available on precision fasteners. Described are locked-in studs, press-lock principle and the one-piece locked-in insert. Ideas for practical applications are also presented. Rosan, Inc.

Circle No. 87, Pages 145-146

Rotary kilns . . . literature is available on a basic brick used in the hot zone of the rotary kilns. It explains properties, applications, advantages, and chemical analysis and installation data. Pangborn Corp.

Circle No. 88, Pages 145-146

Insulation . . . a new light-weight refractory fiber form is described on a product information sheet. Lists the available forms, recommended uses, and advantages of the chemically stable material. Tabular data included are thermal conductivity at various densities and temperatures, and listings of standard densities and thicknesses. Johns-Manville Corp.

Circle No. 89, Pages 145-146

Relays . . . booklet describes a completely integrated line of control relays available, by means of color-coded information on conversion kits for modifying relays. Seven color-location diagrams show how and where to use conversion kits on standard mounting plates. Coil application data show how to select magnet coils for relays with any possible circuit arrangement. Clark Controller Co.

Circle No. 90, Pages 145-146

Vacuum spectrometer . . . yields over 1000 determinations in continous 8-hour operation and may be handled by regular laboratory personnel. Gives simultaneous quantitative results for all important elements including phosphorus, sulfur, and carbon in less than 2 minutes. Four-page booklet shows cutaway drawings and operating features. Applied Research Laboratories, Inc.

Circle No. 91, Pages 145-146

Cost-cutting materials handling . . . ideas are compiled in 80-p handbook. Covers pros and cons on various types, specials versus standard trucks, pallet versus palletless handling, and how to select the right truck for the right job. Automatic Transportation Co., Div. Yale & Towne Mfg. Co.

Circle No. 92, Pages 145-146

training films

The following list of motion pictures and film strips will prove useful in educating your personnel to better perform their jobs. Circle the appropriate number on the Literature Request Card.

Automatic Blow Squeeze . . . sound and color film, 12 min. Shows a highly mechanized molding line. Donated to AFS by Osborn Mfg. Co., Cleveland, available to AFS Chapters without cost except for transportation. American Foundrymen's Society.

Circle No. 93, Pages 145-146

Fork Lift Trucks . . . sound and color slide film, 20 min. Illustrates application of 15,000 to 40,000 lb capacity pneumatic-tired fork trucks in outdoor applications. Available without charge. Request "Dollars and Sense," Slide Film Dept., Industrial Truck Div., Clark Equipment Co., Battle Creek, Mich.

Circle No. 94, Pages 145-146

Cast Metals and You . . . sponsored by AFS Education Division, 16 mm, color and sound, 22 min. Shows role of castings in every day life, emphasizes career opportunities, training facilities, typical examples of cast metal operations. Free to civic and educational institutions; $10 per showing to others. American Foundrymen's Society.

Circle No. 95, Pages 145-146

Study of Vertical Gating Design . . . 16 mm, color and sound, 32 min. Shows technique to reduce turbulence to a minimum during pouring of castings having a height of at least 30 in. Rental: $20 per showing plus transportation. American Foundrymen's Society.

Circle No. 96, Pages 145-146

Effect of Horizontal Gating Design on Casting Quality . . . 16 mm, color and sound, 35 min. Shows study of the hydro-dynamic behavior of metal poured into mold and the effect of design changes in the gating system to eliminate turbulence and aspiration of gases resulting in defective castings. Rental: $20 per showing plus transportation. American Foundrymen's Society.

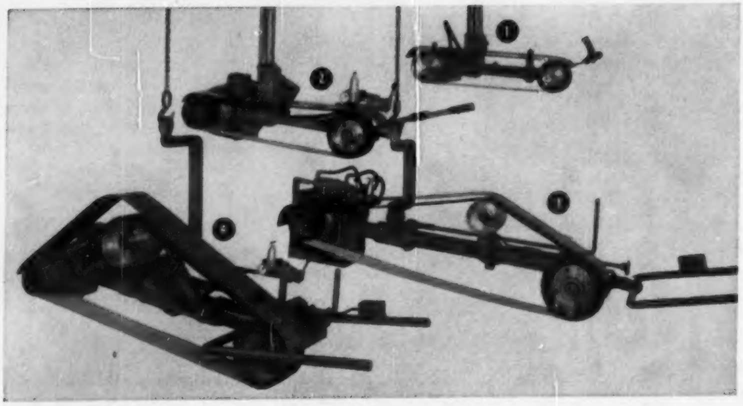
Circle No. 97, Pages 145-146

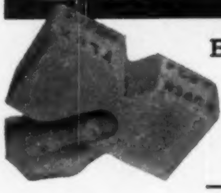
Die casting: how else would you make it . . . 16-mm, sound and color film, 35 min., is available without cost to industrial organizations, schools, colleges, technical groups and clubs. Produced by American Zinc Institute and being distributed by Modern Talking Picture Service, Inc., Dept. MC, East 54th St., New York, N. Y.

Circle No. 98, Pages 145-146

Zinc controls corrosion . . . 16-mm, sound and color film by American Zinc Institute. No charge to industrial organizations, schools, colleges, technical groups and clubs. Running time, 38 min. Distributed by Modern Talking Picture Service, Inc., Dept. MC, 3 East 54th St., New York, N. Y.

Circle No. 99, Pages 145-146





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MANUFACTURERS REPRESENTATIVE — Manufacturer of quality products wants representatives for the Washington, Oregon area; the Alabama area and the Texas area. Excellent, repeat business products. Exclusive representation will be awarded to qualified representatives. Send brief resume. All replies confidential. **Box B-112 H, MODERN CASTINGS, Golf and Wolf Roads, Des Plaines, Ill.**

FOUNDRY SUPERINTENDENT: For foundry in midwest producing large gray iron and ductile iron castings. Must be capable of taking complete charge. **Box B-110 H, MODERN CASTINGS, Golf and Wolf Roads, Des Plaines, Ill.**

METALLURGIST — With investment casting experience. Forward resume with salary requirements. Location—Philadelphia area. **Box B-109 H, MODERN CASTINGS, Golf and Wolf Roads, Des Plaines, Ill.**

FOUNDRY FOREMAN, highest caliber individual for very responsible position with exceptional growth potential, to supervise molding, pouring, coreroom, and shakeout; experience in corrosion resisting steel desirable. **Box B-108 H, MODERN CASTINGS, Golf and Wolf Roads, Des Plaines, Ill.**

FOUNDRY EQUIPMENT AND SUPPLY SALESMAN—Qualified man wanted to cover Illinois and Indiana for Foundry Supply House. Complete knowledge essential. Car furnished. Reply **Box B-100 H, MODERN CASTINGS, Golf and Wolf Roads, Des Plaines, Ill.**

MANUFACTURERS AGENT OR AGENTS to cover five states: Ohio, Indiana, Illinois, Michigan, Wisconsin. Represent New York house sale equipment supplies precision investment casting foundries. Protected area, liberal commission. **Box A-100 H, MODERN CASTINGS, Golf and Wolf Roads, Des Plaines, Ill.**

NON-FERROUS FOUNDRY SUPERINTENDENT for well-known jobbing foundry in Chicago suburb. Strong metallurgical background required. Please send detailed resume, including salary requirements. **Box B-113 H, MODERN CASTINGS, Golf and Wolf Roads, Des Plaines, Ill.**

FOUNDRY METALLURGIST
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JR. FOUNDRY METALLURGIST
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Both positions offer advancement and are with companies well respected. Clients assume the expenses. Contact Paul Sheldon
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PLANT ENGINEERS
Experienced on layout of all types of foundry equipment, material handling and material flows. Send complete details on work history, education and family status. Include recent photograph. All replies confidential. **Box F-140, MODERN CASTINGS, Golf and Wolf Roads, Des Plaines, Ill.**

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Wheelabrator Tumblast—Rubber belt or Steel Flight Machines 1950 or later. **Box B-105 W, MODERN CASTINGS, Golf and Wolf Roads, Des Plaines, Ill.**

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Foundry Equipment all types "What may be obsolete to you," We may be able to use. **Box B-104 W, MODERN CASTINGS, Golf and Wolf Roads, Des Plaines, Ill.**

WANTED
Simpson #3—F Muller or Beardsley Piper #80 1952 or Later. **Box B-103 W, MODERN CASTINGS, Golf and Wolf Roads, Des Plaines, Ill.**

WANTED
Beardsley & Piper Mulbaro
Beardsley & Piper Screenerator
Core Blowers—Bench & Floor to 125# Core
Box B-102 W, MODERN CASTINGS, Golf and Wolf Roads, Des Plaines, Ill.

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Molding Machines
Osborne 275
Osborne 276
Osborne Rotolifts
Box B-101 W, MODERN CASTINGS, Golf and Wolf Roads, Des Plaines, Ill.

POSITION WANTED

PATTERN ENGINEER—SUPERVISOR. Eighteen years experience in ferrous foundries and pattern shops. Familiar with all phases core room and foundry practice, gating, risering, pattern and casting design and shell molding. **Box B-106 P, MODERN CASTINGS, Golf and Wolf Roads, Des Plaines, Ill.**

FOUNDRY SUPERINTENDENT, metallurgist with experience in quality control and trouble shooting. Knows gating, risering, melting and pouring practices, plus sand. Been liaison between foundry, pattern shop, machine shop and engineering. **Box B-114 P, MODERN CASTINGS, Golf and Wolf Roads, Des Plaines, Ill.**

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Detroit Rocking Indirect Arc Electric Furnace Type LFC, 125 KW, Capacity 350 lbs. cold scrap, 500 lbs. of molten metal. Two shells, complete with automatic electrode control, main control panel and power transformers for 12,000 volt primary power supply. All equipment used very little and in excellent condition. Immediately available. Make offer to: **Box B-111 S, MODERN CASTINGS, Golf and Wolf Roads, Des Plaines, Ill.**

3-Phase Arc Furnace, Moore Rapid 'Lectromelt, size T, 4000/2300 volt, 60-cycle, 500 lb./hr. capacity, with control panel, less transformer and transformer controls. Make offer to, or obtain further information from, **Linde Company, Laboratory Works Engineering Department, 1500 Polco Street, Indianapolis 24, Indiana.**

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Casting Quality Chart Reprints

It is still possible to obtain single or quantity copies of the informative, two-color Casting Quality Chart reprinted from the October '60 issue of MODERN CASTINGS.

A personal copy of the chart, which lists casting defects and remedies in easy-to-follow form, is free to readers. Additional copies for convenient plant or office use . . . the chart is suitable for mounting on the wall . . . can be ordered at 25¢ each.

With orders being filled on a first-come, first-served basis, readers are asked to write as soon as possible.

Quantity orders will also be filled promptly.

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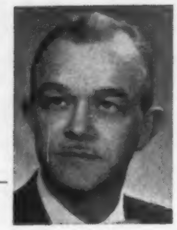
The Editor's Forum . . .



How can one cupola . . . meet maximum demands of vacillating production needs? Sealed Power Corp., Muskegon, Mich., has a good answer to this one. John Von Haver, Foundry Manager, explained to me how they meet the problem by lining the cupola down to 36 inches inside diameter when production needs are lowest. Then when business picks up they let lining burn back to give melting rate required. Maximum output is obtained when lined to an inside diameter of 56 inches. The same ingenuity can be used to spread cupola melting campaign out for a longer day or speeding it up for fast pour-off. This choice depends of course on the nature of molding-pouring integration in each individual shop. So variable cupola diameter is one way of introducing additional flexibility on your foundry operations.

While walking through the Oberdorfer Foundry in Syracuse, N. Y. . . . largest independent nonferrous foundry in the United States . . . Bill Dunn, assistant to the president, pointed out a few innovations well worth passing onto MODERN CASTINGS readers:

1. If you have intermittent need for a number of core sand mixes, store them in hoppers that can be transported by fork-lift truck to the muller, to storage racks, and to core making stations. Watch MODERN CASTINGS for a complete story on this practice soon!

2. Counteract moisture condensation on cold patterns by mounting on molding machines infra red lights aimed at pattern surface.

3. Every time molder sets a completed mold on the roller conveyor behind him it actuates a switch which turns on electric power to drive the rollers. Timing switch shuts off power as soon as the line of molds has moved down far enough to make room for setting next mold on the conveyor. Not only does this save a lot of time but also a lot of muscle if molder has to push a whole line of molds on dead rollers each time he clears a space for the next mold.

I never come away from a foundry visit without feeling that every foundryman should make a point of getting out at least once a month to visit a foundry in his area. You can't help but benefit from seeing what the other fellow is doing. And you can often make suggestions that will help him. American Foundrymen's Society Chapters and Regional Conferences have found plant visits one of the most popular items on their programs. Instead of wishing we could afford to tour European foundries why not see "America's Foundries First"? Language will be no problem, much of what you see is readily applicable to your own operations, and you don't need a month's vacation and $2000 to do it. Get acquainted with your neighbors, the foundry you help may be your own.

Pull for Quality . . . Push for Quality . . . these messages greet every foundry employee as he pushes or pulls a door open in the Rock Island Foundry of International Harvester Co. By constant repetition of this important word—QUALITY—it is soon reflected in everyone's work and in the end product—quality castings.

Digging a casting out of a pit mold . . . is usually a laborious task. And if it is cement molding sand the job is even worse. George Martin, Foundry Superintendent at Chambersburg Engineering Co., showed me how they have managed to mechanize this traditionally tedious hand labor operation. They bought a rubber tired tractor equipped with a front-end loader on one end and a back-hoe on the other. One man using the back-hoe can now dig out a 20 x 20 x 6 foot pit mold in eight hours. Previously it required 55 man-hours of hard hot dusty hand labor. Besides saving time and money Chambersburg has made their foundry a better place to work through imagineering.

Look around your own shop and decide which job you will like to do the least. Then do your best to clean it up.

Jack H Schaum

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1. BINDERS FOR EVERY CORE PROCESS: Featuring CHEM-REZ A-200, the chemically-reactive binder that "bakes" at room temperature; CHEM-REZ "100", with hot box curing, makes intricate cores at high production rates; LIN-O-SET, ADM's air-setting binder; ADCOSIL, for CO_2 gas-cured cores; ADMIREZ foundry resin for shell molds and cores; LINOIL and INDUCTOL, industry's most reliable oils for quality baked-sand cores.

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